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Descriptions and Distributional Records of American Mecoptera. IV.<sup>1</sup>

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## ABSTRACT

Sixteen new species are described and illustrated. These are *Panorpa capillata* (southeastern U.S.A.); *P. involuta* (Veracruz), *P. contorta* (San Luis Potosí and Hidalgo), *P. ramosa*, *P. mucronata* and *P. reclusa* (Hidalgo), *P. attenuata* (San Luis Potosí), *P. bimacula* (Oaxaca), *P. sarta* (Michoacán), *Bittacus sylvaticus* (Veracruz) and *B. peninsularis* (Baja California Sur) from Mexico; *Kalobittacus maniculatus* (Guatemala), *K. demissus*, *K. inornatus* and *Bittacus disternum* (Costa Rica), and *Bittacus spatulatus* (Costa Rica and Nicaragua). A lectotype is designated for *Panorpa terminata* Klug, and the male is illustrated. First known males of *Bittacus pignatellii* Navás, from Panama, and *Bittacus maculosus* Byers, from Trinidad, are illustrated and briefly described. Some new distributional data for various species are provided.

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## INTRODUCTION

Students and faculty associated with the Snow Entomological Museum at the University of Kansas have in recent years done extensive collecting of insects in Mexico and Central America. Some results of this collecting include new species of Mecoptera described here, as well as new information about the geographic occurrence of other species. Additional new species and distributional data are based on collections received for identification from other sources.

Descriptions of wing venation follow the widely used Comstock-Needham system. Particularly with reference to the Bittacidae, in the taxonomy of which wing venation has long been utilized, some additional abbreviations have been used by Esben-Petersen, others by me. These are: FM - first fork or branching of the media; FRs - first fork of the radial sector; OM - origin of the media from  $Cu_1$  (applies here to Bittacidae only); ORs - origin of the radial sector from R (or  $R_1$ ); Scv - subcostal cross-vein, from Sc to  $R_1$ .

No keys are included for most of the several Mexican or Central American species described here because so many remain to be described that a key could be misleading; however, a tentative key to the *Panorpa involuta* species group in Mexico is included.

## ACKNOWLEDGMENTS

For the loan specimens, I am indebted to the following entomologists whose collections are indicated hereinafter by the initials in parentheses:

- Mr. Wes Bicha - private collection in Oliver Springs, Tennessee (WB).  
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 Dr. Roy R. Snelling - Natural History Museum of Los Angeles County, Los Angeles, California (LACM).  
 The Snow Entomological Museum is abbreviated SEM.

I particularly thank my colleague Wes Bicha for making so many specimens and collection records available for my use and for his helpful comments on this paper.

Two species of *Bittacus* described here (*B. disternum* and *B. spatulatus*) were included, in 1985, in an unpublished master's thesis by Mr. Ricardo Roggero, then a student at the University of Kansas. I had illustrated and tentatively named them, and he described them, which I acknowledge with thanks. The descriptions here, however, are not his and are based on many additional specimens collected in more recent years.

I wish to thank Sharon Hopkins and Judy Wiglesworth for their

patience in entering the paper into computer from my typed and revised copy.

*Panorpa capillata* new species

Description based on 37 males, 13 females pinned, and 5 males, 5 females in alcohol.

*Head*: Dorsum unevenly yellowish brown except piceus around ocelli; rostrum yellowish brown to amber brown (probably post-mortem color change), terminal segment of maxillary palps apically to wholly brown. Antennal scape yellowish brown, pedicel darker, flagellum dark brown, with 33 to 37 flagellomeres.

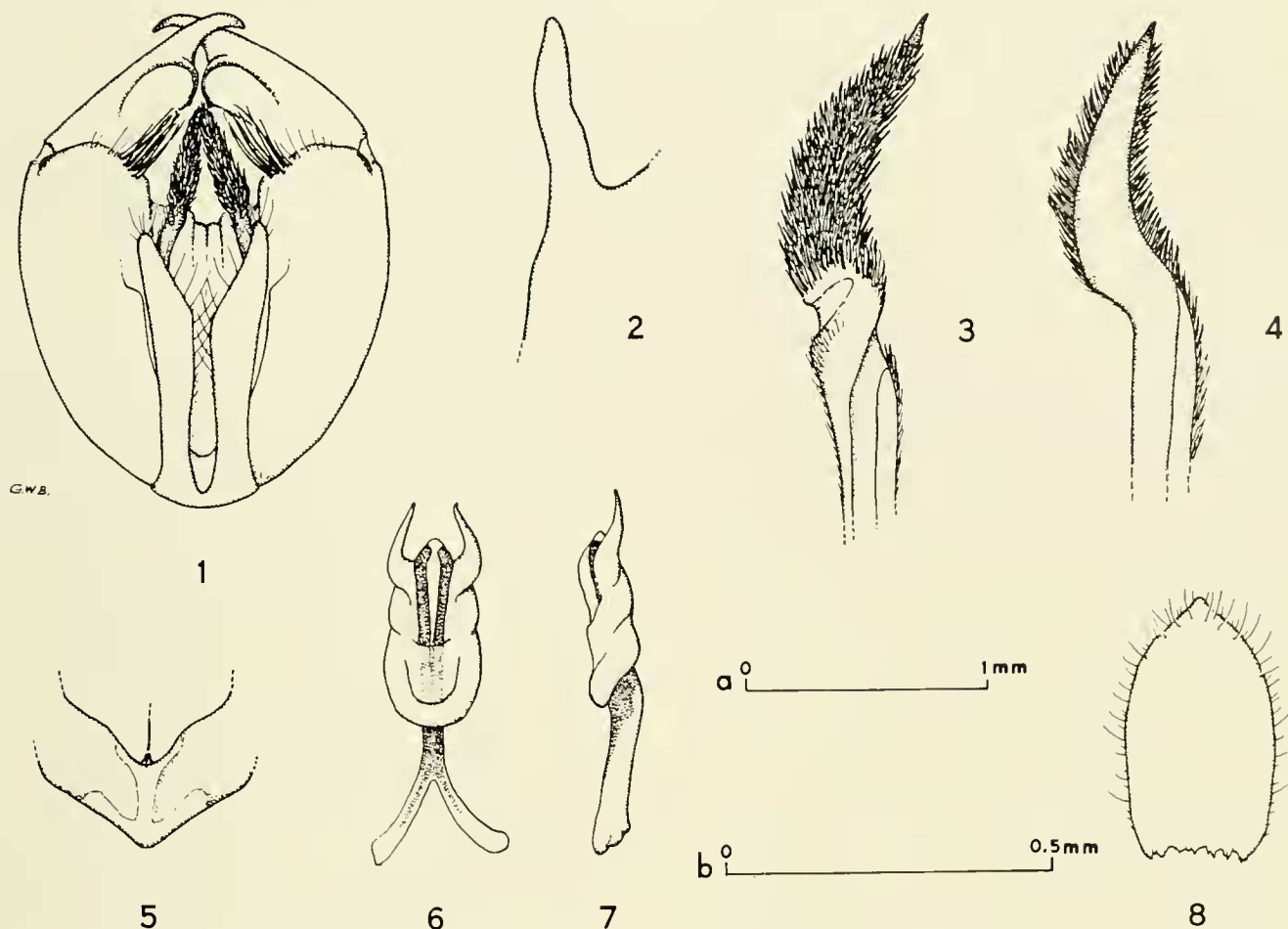
*Thorax*: Pronotum dull yellowish gray, transversely rugose, with 8 black setae along anterior margin and 2 near posterior margin. Mesonotum yellowish gray with diffuse gray-brown spot at base of each forewing and at anterior edge on each side, spots connected in some individuals. Metanotum sordid yellowish brown to yellowish gray. Pleural surfaces, coxae and mera unevenly amber brown with short, sparse pale hairs, most evident on anterior surfaces of coxae. Femora, tibiae and tarsi pale yellowish brown; conspicuous black setae on tibiae and tarsi.

Wings tinged with pale yellowish brown, sparsely spotted with grayish brown. No complete bands; most cross-veins in distal two-thirds of wing darkly margined; outer radial cells darkened near wing margin in some individuals, especially females. Pterostigmal spot larger than others. First and second basal spots present; humeral spots absent.

*Abdomen of male*: Unevenly sordid yellowish brown throughout, with short, pale pubescence. No posterior horn on sixth segment. Notal organ a slightly extended, broadly rounded caudal margin on tergum 3, with long, down-curved setae, and a median, setose process on anterior tergum 4. Hypovalues of sternum 9 (Fig. 1) widened beyond mid-length, then narrowed toward apex, with pale yellowish setae along mesal margins except those near apex thickened and darkened to brown in some males. Tergum 9 bilobed, with subrectangular space between lobes. Inner, apical (postero-ventral) margin of each basistyle bearing group of 6-9 black setae of varying thickness, their acuminate tips extending into basal cup of respective dististyle. Outer margins of dististyles (ventral aspect) nearly straight, except apical portion strongly curved and darkly sclerotized; basal cup shallowly concave, ventro-mesal in position, with strongly sclerotized, amber-colored border complete except basally. Ventral parameres (Fig. 3) twisted and transversely grooved near mid-length, with dark amber "barbs" (stout setae) covering ventral and most of lateral surface of apical half of each, except for glabrous, acute apex; marginal barbs of basal half pale, short. Dorsal parameres (Fig. 2) yellowish, dorso-ventrally flattened, blade-like, short, usually concealed by ventral parameres in ventral aspect. Ventral and dorsal valves of aedeagus short, concealed in ventral aspect. Base of aedeagus without distinct hamulus (Byers, 1993: 59), lateral walls of projection forming cup-like structure concave caudally (Fig. 5).

*Abdomen of female*: Terga 2-6 dark yellowish brown to brown, more terminal segments unevenly yellowish brown; corresponding sterna paler, yellowish brown. Subgenital plate of sternum 8 (Fig. 8) mostly flattened ventrally; lateral margins curved upward, apex narrowly rounded, pale (slightly projecting in a female from Rainsville, Alabama, Fig. 8), major marginal setae sparse along sides, more numerous (several submarginal) near apex. Genital plates (Figs. 6, 7) with prolongations of apical plate slender, acute, bowed outward; basal plate roughly U-shaped; axial portion compressed (deeper than wide), extending beyond postero-median margin of apical plate; anterior apodemes slender in ventral aspect, strongly divergent.

*Measurements*: Body length (based on pinned specimens), male, 9.8-11.3 mm. (holotype 10.4 mm.); female, 10.0-11.2 mm. (allotype 10.0 mm.). Length of front wing, male, 9.2-12.0 mm. (holotype 11.0 mm.); female, 9.9-13.1 mm. (allotype 12.1 mm.). Antennal length, male holotype, about 7.3 mm.; female allotype about 7.4 mm.



**Figs. 1-3, 5-8.** *Panorpa capillata* n. sp. 1, genital bulb, male holotype, ventral aspect (most hairs omitted). 2, right dorsal paramere, male paratype, ventral aspect. 3, left ventral paramere of male, ventral aspect. **Fig. 4**, left ventral paramere, topotypic male of *Panorpa signoides* Carpenter, ventral aspect. 5, lower portion of aedeagus of male, ventral aspect. 6, genital plates of female paratype, ventral aspect. 7, same, right lateral aspect. 8, subgenital plate of female. Scale a, figs. 1, 6-8; scale b, figs. 2-5.

**Types:** Holotype, male, and 1 male paratype, 10 mi. (16 km) north of Fayette, Fayette Co. (GWB field catalogue no. 1), Alabama, 24 May 1978, G. W. Byers and C. W. Young. Allotype, female, 6 male and 3 female paratypes, Tombigbee State Park southeast of Tupelo, Lee Co. (no. 2), Mississippi, 24 May 1978, G. W. Byers and C. W. Young. Additional paratypes: ALABAMA: Bibb Co., 6 May 1990, Wes Bicha (5 males; WB); Choctaw Co., 0.5 mi. W. of Butler, 23 April 1994, Wes Bicha (2 males; WB); Choctaw Co., 11 April 1982, Wes Bicha (2 males, 1 female; SEM); DeKalb Co., DeSoto State Park, 20 May 1993, G. W. Byers (3 males; SEM); same but 19-23 May 1990, T. Schiefer (1 male; SEM); same but 18-24 May, R. Brown & D. Pollock (1 male; SEM); DeKalb Co., 3.2 km N of Rainsville, 3 June 1975, G. W. Byers (4 females; SEM); Madison Co., Monte Sano State Park, 12 May 1988, D. W. Brzoska (2 males, 2 females; SEM); Marion Co., 30 May 1982, Wes Bicha (1 male; WB); Winston Co. (no. 2), 8.9 km NE of Double Springs, 19 May 1993, G. W. Byers (1 male; SEM). ARKANSAS: Montgomery Co. (no. 1), 14.4 km N of Pencil Bluff, 21 May 1978, G. W. Byers and C. W. Young (2 females; SEM); Montgomery Co. (no. 2), Gap Creek, 2.1 km SE of Joplin, Ouachita National Forest, 22 May 1978, G. W. Byers and C. W. Young (1 male; SEM); Polk Co., Rich Mountain, pitfall trap, 6 July - 10 Nov. 1995, H. W. Robison (2 males; SEM). KENTUCKY: Livingston Co., 31 May 1982, Wes Bicha (2 males, 2

females; SEM); Trigg Co., 8 May 1982 (2 males; WB) and 31 May 1982, Wes Bicha (4 males; WB, SEM). MISSISSIPPI: Lafayette Co. (no. 1), Puskus Lake, 12.8 km NE of Oxford, 23 May 1978, G. W. Byers and C. W. Young (4 males, 3 females; SEM); Lee Co., Tombigbee State Park, 18 May 1993, G. W. Byers (4 males; SEM); 5 May 1982 (1 male) and 30 May 1982, Wes Bicha (5 males; WB, SEM) TENNESSEE: McMinn Co., 20 May 1986, Wes Bicha (1 male; WB). Holotype, allotype and most paratypes in the SEM; 1 male, 1 female paratypes in the USNM; 9 males in collection of WB.

The type locality is a Forestry Research Station of Auburn University, on U. S. Highway 43. *Panorpa capillata* was collected from honeysuckle (*Lonicera*), with brambles (*Rubus*), various composites and poison ivy in the same habitat, all shaded by an almost pure stand of tulip trees (or yellow poplar, *Liriodendron tulipifera*), planted in 1953. The understory is typical habitat for this species, usually found in ecotones between woodlands and open fields. At other places where *P. capillata* was collected, the habitat was honeysuckle, brambles, poison ivy, in some places greenbrier and always various broad-leaved herbaceous plants, but the



trees providing shade were of many species. Wes Bicha has found *capillata* (and its more northern counterpart, *P. sigmoides*) also in deep shade along small streams. *P. capillata* is often found together with the similar and probably closely related *P. nebulosa* Westwood.

For some time, I had tentatively identified this species as an aberrant form of *Panorpa sigmoides* Carpenter; but it became apparent that *sigmoides* has a more northern range (Indiana, Illinois, Ohio, Wisconsin, Minnesota), while all specimens of the *capillata* form are from the southern states. It will be interesting to see what future collecting in Kentucky and Tennessee will reveal about the relationships of these two forms.

*Panorpa capillata* belongs to the *nebulosa* group of species (Carpenter, 1931: 221) and in many details of both males and females resembles *sigmoides* and *nebulosa*. Males of *capillata* may be easily differentiated from both by the ventral parameres (Figs. 1, 3). These are slender and largely bare but have short barbs along the inner edge, in *nebulosa*. The apical one-third of each ventral paramere is expanded, then narrowed to an acute tip, in *sigmoides* and *capillata*, and the barbs are longer. In *capillata* the ventral aspect of a ventral paramere (Fig. 3) shows the apical portion of the paramere covered by dense, slender, recumbent barbs, except on the extreme tip. It is the hairy appearance of the ventral parameres that gives the species its name (Latin *capillata* = hairy). On the dorsal surface, there is a glabrous zone approximately one-third the width of the paramere. The same structure in *sigmoides* (Fig. 4) is broadly glabrous on the ventral surface, with bordering barbs. In *capillata* most setae along the mesal margins of the hypovalves of the ninth sternum are slender and yellowish, but in *sigmoides* they are dark brown to black. And in *capillata* the apical, ventro-mesal setae of the basistyles are thick and black; these are rarely thick or dark in *sigmoides*.

In comparing *capillata* and *sigmoides*, it should be noted that there are some errors in the original description of the latter (Carpenter, 1931: 250-251, fig. 37). The hypovalves are not particularly long and do not reach the ends of the basistyles; neither is the genital bulb elongate and slender. A composite drawing of ventral and antero-ventral aspects of the genital bulb could possibly result in these faulty impressions.

Differentiating females of *capillata* from those of *sigmoides* and *nebulosa* is difficult. In general, there are four spots along the posterior margin of the forewing, in *capillata*; these are (1) a remnant of the proximal edge of an apical band, (2 and 3) in the positions of the branches of the pterostigmal band, and (4) the second basal spot (actually near but not on the margin). These markings are larger and more densely pigmented in *sigmoides* and *capillata* than in *nebulosa*. The genital plates of *capillata* are more slender in ventral aspect than those of *nebulosa* and less slender than those of *sigmoides* (compare my figure 6 with figures 65 and 66 in Carpenter's 1931 revision).

An interesting circumstance, possibly of biogeographical significance, is that there exists in Japan a pair of species

having much the same morphology of the male's genital bulb as in *capillata* and *sigmoides*. Particularly with regard to the ventral parameres and the apical setae on the basistyles, *Panorpa kirisimaensis* Issiki is very like *capillata*, and *P. kamikotiensis* Issiki is very like *sigmoides* (Issiki, 1929: 184-187). These Japanese species occur on the islands of Kyushu and Honshu, respectively. Unlike *capillata* or *sigmoides*, they have a horn-like projection from the sixth abdominal segment in males, complete pterostigmal band on the wings, and other differences.

### The *Panorpa involuta* species group

The following six species – *Panorpa involuta*, *P. contorta*, *P. ramosa*, *P. mucronata*, *P. reclusa* and *P. attenuata* – belong to a group apart from other Mexican species of *Panorpa*. As a group they are found in the eastern mountains of Mexico, from approximately the latitude of Ciudad Mante southward to the vicinity of Orizaba. It seems probable that additional species in this group will be discovered within the 500-kilometer band of mountains indicated. In fact, it is likely that *Panorpa mexicana* Banks (1913), known only from its male holotype from Orizaba, belongs to this *involuta* group of species. All six have, in the male, a very complicated aedeagus unlike that seen in other Mexican *Panorpas*, hence the name given to the one included species and to the group. And all have when alive a decidedly green color, most noticeable in the pleural region of the abdomen and thorax. Whether this pigment is derived from the diet of the scorpion-flies or has some other source (e.g., metabolic) is at present unknown.

A key to the species of the *involuta* group (and including *P. mexicana*) follows the species descriptions.

### *Panorpa involuta* new species

Description based on 52 males, 40 females, pinned, and 3 males, 17 females in alcohol. Colors based on pinned specimens.

**Head:** Dorsum unevenly light brown to brown; black around ocelli. Rostrum and frons below ocelli yellowish brown to pale brown except rostrum darker brown at sides (apex of rostrum retains green pigment in many individuals); most mouthparts dark brown to black, maxillary palps basally brown, grading through dark greenish gray to almost black on terminal segment. Scape and pedicel yellowish brown, flagellum dark brown with 35-37 flagellomeres, basal one longer than second and third together.

**Thorax:** Pronotum brown with elevated portions of lateral transverse folds slightly darker; 5-7 thick, black setae at each side on anterior margin. Mesonotum unevenly brown, palest medially gradually darkening at sides (but without pattern), with numerous small, recumbent black setae longest at sides and on scutellum; 1-3 erect black setae above each wing base. Metanotum brown without markings, with numerous short but no long setae. Pleural surfaces, coxae and mera dark yellowish brown to reddish brown, with scattered pale hairs, longest and most dense on anterior surfaces of coxae. Femora yellowish brown, with grayish tinge in some specimens; tibiae and basitarsi darker, grading into dark reddish brown on distal tarsomeres.

**Wings** (Fig. 99a) moderately iridescent, lightly tinged with gray, markings brown to pale grayish brown. Apical band from slightly before end of  $R_5$  to slightly behind end of  $M_3$  but pigment diffuse and clear areas included; in males, apical band often reduced to



clouding over outer radial and medial cross-veins and narrow darkening along apical wing margin. Pterostigmal band covering basal half of stigma, extending to  $M_1$  then narrowly connected to more slender continuation of band across first cell  $M_1$  to end of  $M_4$ ; in some males band interrupted from  $M_1$  to  $M_2$ . Narrow transverse spot from  $M_3$  to end of  $Cu_1$ , another from  $R_1$  across first fork of  $Rs$  to  $M_1$  (may be weak between  $R_{2+3}$  and  $R_{4+5}$ ); wider spot from  $Cu_1$  to  $Cu_2$  about midway between cubital cross-veins; small spot at origin of  $Rs$ , from  $Sc$  across  $R_1$  to  $Rs$ . Whitish thyridium at first fork of  $M$ .

**Abdomen of male:** Terga 2-5 from evenly medium brown to sordid darker brown, corresponding sterna paler brown; segments 6-9 brown. Notal organ weakly developed: narrow, short projection from posterior margin of tergum 3 with few downcurved, black setae; small, sclerotized, forwardly projecting point on tergum 4. Dorsum of segment 6, in lateral aspect, conspicuously concave in posterior half. Hypovalves (Fig. 9) short but exceeding ventral connection between basistyles, borne on gradually narrowing prolongation of ninth sternum nearly twice length of hypovalves, in ventral aspect. Tergum 9 (Fig. 10) narrowed gradually past level of cerci; apex shallowly emarginate. Basistyles separated less than half their length, in ventral aspect. Inner, postero-ventral margin of each basistyle bearing about 12 mesally directed setae (Fig. 11); other setae on mesal surface of basistyle. Outer margins of dististyles slightly concave before mid-length; basal cup of dististyle elongated ventro-mesally, shallowly concave on lower (anterior) surface; row of long hairs extending from basal cup past mid-length of dististyle; inner margin of dististyle with sharp, strongly sclerotized, downwardly curved point concealed by basal cup in ventral aspect (Fig. 12). Ventral parameres two-branched (Figs. 22, 23), ventral branches elongate, with apices crossing and projecting conspicuously from genital bulb in lateral aspect; dorsal branches elongate, each bearing pendulous, membranous inner appendage. Dorsal parameres elongate, not darkly sclerotized, with two acute, triangular "teeth" on ventro-lateral surface of each and two tiny "teeth" nearer base. Ventral valves slender, dark but not densely sclerotized, evenly curved, tips usually visible between tips of lower branches of ventral parameres; dorsal valves short, blunt, dark and densely sclerotized.

**Abdomen of female:** Terga 2-4 or 2-5 unevenly brown, sterna paler; more posterior segments grayish brown, sometimes with faint indication of green. Subgenital plate (Fig. 13) slightly widened behind mid-length, posterior margin broadly rounded with about 20 setae longer than others on plate. Genital plates (Fig. 24) narrow, with only small, nearly transparent lateral extensions representing apical plate, "basal plate" semimembranous and poorly defined, attached to adjacent tissues anteriorly; axial portion strongly sclerotized but anterior ends of slightly divergent apodemes relatively pale. In lateral aspect, structure nearly straight, anterior ends of apodemes curved slightly ventrad.

**Measurements:** Body length (based on pinned specimens), male, 8.6-11.0 mm (holotype 10.3 mm); female, 8.4-12.0 mm (allotype 10.5 mm). Length of fore wing, male, 10.7-11.6 mm (holotype 11.4 mm); female 11.3-12.8 mm (allotype 12.2 mm). Antennal length, male, about 8.7 mm, female about 8.5 mm.

**Types:** Holotype, male, collected in cloud forest, 4.8 miles (7.7 km) northeast of Coscomatepec, Veracruz, Mexico, elevation about 1420 m, on 8 August 1969, by G. W. Byers (field cat. Veracruz no. 17). Allotype, female, same data but 9 August (no. 18). Paratypes, 15 males, 13 females, pinned, 3 males, 5 females in alcohol, same data as holotype; 16 males, 11 females, pinned, 12 females in alcohol, same data as allotype; same locality but 23 June 1971, N. D. Penny (5 males, 3 females, SEM); same locality but 31 August 1971, G. W. Byers and R. Thornhill, 8 males, 9 females, SEM; Veracruz, Coscomatepec, km 29, 16 August 1993, Wes Bicha (7 males, 3 females, WB). Holotype, allotype and most paratypes are in the SEM; paratypes have been sent to the USNM, the MCZ, the UMMZ and some other collections.

This species takes its name from the complicated aedeagus of the male (Latin *involuta* = complex, intricate).

At the time I first collected this species, the habitat was cloud forest of numerous kinds of tropical broad-leaved trees, some tree-ferns, shrubs, many vines, ferns, mosses, abundant bromeliads and other epiphytes on tree branches, and a peculiar ground cover of *Selaginella* about 10-15 cm. deep. Returning to the site three years later, I found that while some of the highest trees had been left to provide shade, most of the lower trees and native shrubs had been cut and burned, and coffee shrubs planted in their place. There were extensive areas of bare or nearly bare soil with only patches of *Selaginella* left. Nevertheless, *P. involuta* was still present, especially in streamside leafy, herbaceous vegetation.

When alive, *Panorpa involuta* displays a bright green (less often yellowish green) color, particularly noticeable on the thoracic and abdominal pleura, rostrum and legs but even in some well sclerotized structures, for example, the genital bulb of males. Eventually this color largely disappears from specimens pinned and dried, but it leaches out rapidly from those preserved in alcohol.

*Panorpa involuta* somewhat resembles *P. mexicana* Banks, a species still known only from its male holotype, collected near Orizaba, Veracruz, only about 35 km from the type locality of *P. involuta*. In the male of *involuta*, the hypovalves extend slightly past the edge of the ventral connection between the basistyles, while in *mexicana* they clearly terminate short of this edge. There are numerous dark, conspicuous setae on the posteroventral surface of the basistyle, in *involuta*, but in *mexicana* there are only more slender, shorter and paler setae. The ninth tergum in *involuta* is shallowly emarginate at apex, while that of *mexicana* appears to be rounded (seen only from the side). There are only two spots proximal to the pterostigmal band in the fore wings of the type of *mexicana* but four in males of *involuta*. I did not examine the aedeagus of *mexicana* in detail, but in ventral aspect (cf. Byers, 1962: 303, fig. 8) it is evidently very different from that of *involuta*.

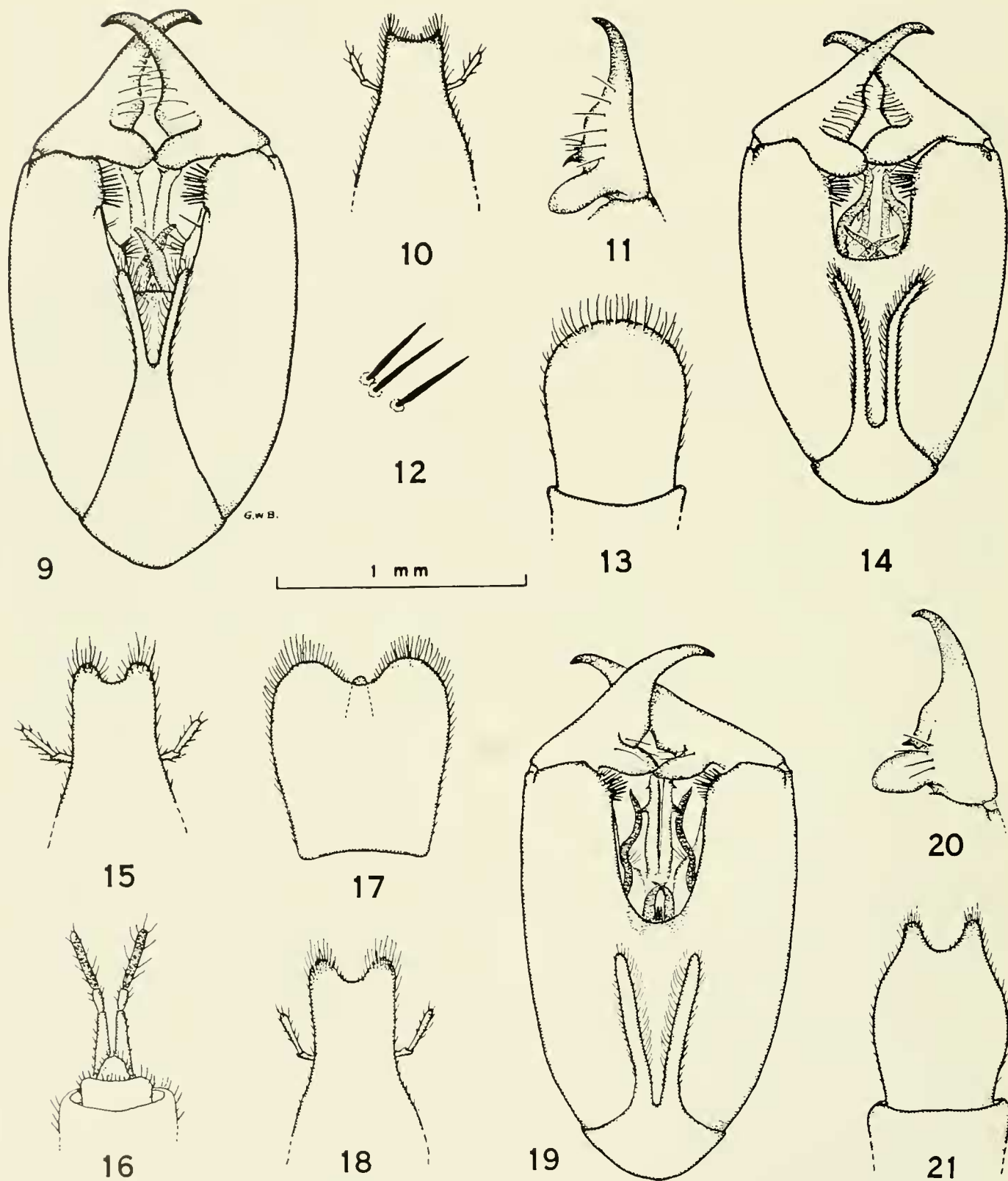
### *Panorpa contorta* new species

Description based on 35 males, 12 females, pinned, 4 males, 1 female in alcohol.

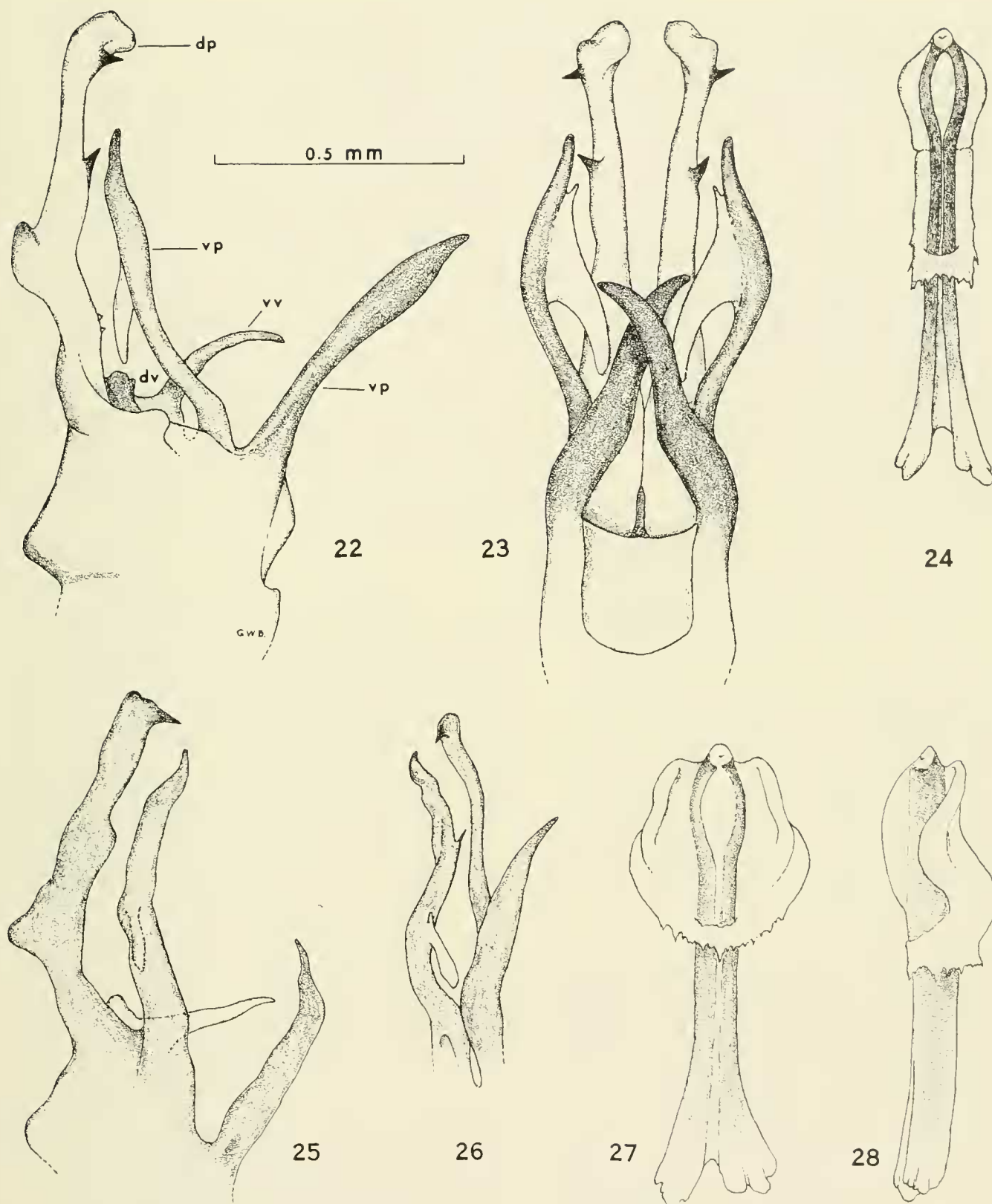
**Head:** Dorsum yellowish brown, dark brown to black around ocelli. Rostrum and frons below ocelli mostly yellowish brown, rostrum slightly darker at sides, with trace of green near apex and in maxillary palps. Apical half of terminal segment of palps blackish brown. Scape yellowish brown, pedicel brown, flagellum dark brown to black with 33-35 flagellomeres, first subequal in length to second and third together.

**Thorax:** Pronotum yellowish brown in depressed areas, slightly darker brown on elevated, transverse ridges or folds; 7-8 black setae on each side of anterior margin. Mesonotum and metanotum unevenly light brown, with short, dark setae directed backward; two longer setae on mesonotal scutellum. Pleural surfaces, coxae and mera unevenly yellowish brown with sparse, pale setae; setae longest and most dense on anterior surfaces of coxae. Femora and tibiae yellowish brown, usually with tinge of green visible in femora; setae black; tarsi light brown.

Wings without any complete bands, tinged with yellowish brown, iridescent, with brown stigma and markings. Narrow darkening at edge of wing in outer radial cells; transverse spot across outer radial cells from about  $R_3$  to slightly behind  $R_5$  or to  $M_1$ . Pterostig-



Figs. 9-13. *Panorpa involuta* n. sp. 9, genital bulb, male holotype, ventral aspect (most hairs omitted). 10, ninth abdominal tergum, male paratype, dorsal aspect. 11, right dististyle, male paratype, posteroventral aspect. 12, setae of ventromesal surface of basistyle. 13, subgenital plate, female paratype. Figs. 14-17. *Panorpa contorta* n. sp. 14, genital bulb, male paratype, ventral aspect. 15, ninth abdominal tergum, male paratype, dorsal aspect. 16, terminal abdominal segments and cerci, female allotype, ventral aspect. 17, subgenital plate, female allotype, ventral aspect. Figs. 18-21. *Panorpa ramosa* n. sp. 18, ninth abdominal tergum, male holotype, dorsal aspect. 19, genital bulb, male holotype, ventral aspect. 20, right dististyle, holotype, posteroventral aspect. 21, subgenital plate, female allotype, ventral aspect. Scale, figs. 9-11, 13-21.



**Figs. 22-24.** *Panorpa involuta* n. sp. 22, aedeagus, male paratype, left lateral aspect; dp - dorsal paramere, dv - dorsal valve, vp = ventral paramere (both branches labelled), vv - ventral valve. 23, same, ventral aspect. 24, genital plates of female, ventral aspect. **Figs. 25-28.** *Panorpa contorta* n. sp. 25, apex of male aedeagus, left lateral aspect. 26, left half of aedeagus, ventral aspect. 27, genital plates of female, ventral aspect. 28, same, right lateral aspect. Scale, all figures.



mal band represented by wedge-shaped spot from basal half of stigma to outer nygma, slightly behind  $R_4$  (interrupted between  $R_4$  and  $R_5$  or offset near fork of  $R_{4+5}$  in some individuals). Small spots in first cell  $R_1$ , at origin of radial sector, between 1A and 2A about halfway between cross-veins, and at end of  $Cu_1$ . Other spots in some specimens. Hind wings with lighter markings, virtually unmarked in some males. Cross-veins in outer radial-medial area usually not bordered in males, or may be slightly bordered, especially in females, most of which have more wing spots than in males (e.g., from end of  $Cu_1$  to  $M_3$ ,  $Cu_1$  to  $Cu_2$  at level of ORs, or at ends of 1A and 2A).

*Abdomen of male:* Terga 2-6 unevenly yellowish brown with short, pale setae; corresponding sterna slightly paler. Notal organ formed of broadly rounded, slight median prolongation of tergum 3 and small peg with sharp tip curved cephalad on anterior tergum 4. Dorsum of posterior half or more of segment 6 depressed, without setae, to accommodate genital bulb when brought fully forward. Hypovalves of ninth sternum (Fig. 14) slender, of nearly uniform width throughout, slightly divergent, extending to or slightly beyond edge of ventral connection between basistyles (may be bent to sides in apical half due to drying), separated at base by width of a hypovalve or more, with yellowish hairs along mesal edges longer and more numerous than those along outer edges. Tergum 9 arched dorsad in basal half, abruptly narrowed at level of cerci, shallowly emarginate and bilobed at apex (Fig. 15). Inner, subapical surface of each basistyle bearing numerous mesally-directed, thick black setae. Outer margins of dististyles slightly concave near mid-length, strongly curved subapically and increasingly sclerotized. Basal cup of dististyle about 1.5 times as long as its greatest width, with pale, curved setae along lower edge, sparse setae on outer curvature. Strongly sclerotized point on mesal margin of dististyle concealed by basal cup in ventral aspect. Both branches of ventral parameres thick, well sclerotized (Figs. 25, 26), with small membranous appendage on somewhat twisted dorsal branch. Dorsal parameres with single spinous projection at apex and heel-like swelling on dorsal surface near base. Dorsal valves short, rounded, inconspicuous; ventral valves elongate, not strongly sclerotized.

*Abdomen of female:* Terga 2-6 unevenly dark yellowish brown to brown; corresponding sterna pale yellowish brown; more terminal segments sordid brown or grayish brown. Basal segment of cercus brown, short (Fig. 16); apical segment black, more than twice length of basal segment; cercal bases unusually deeply separated. Subgenital plate (Fig. 17) broad, apically bilobed with short median projection in most specimens. Genital plates (Figs. 27, 28) with stout axial portion and only distal plate well sclerotized; basal plate largely membranous, its limits indistinct; distal plate curved ventrad at sides. Anterior apodemes thick, moderately divergent.

*Measurements:* Body length, male, about 9.3-11.6 mm (holotype 10.2 mm); female, 9.2-11.0 mm (allotype 9.6 mm). Length of fore wing, male, 10.3-13.0 mm (holotype 10.5 mm); female, 11.5-11.9 mm (allotype 11.6 mm). Antennal length, male, about 8.8 mm, female about 9.9 mm.

*Types:* Holotype male, allotype female, 4 male and 3 female paratypes collected 14.9 miles (23.8 km) by road west of El Naranjo, San Luis Potosí, Mexico, 26 August 1972, elevation 4000 ft. (1220 m), by G. W. Byers and R. Thornhill (GWB field catalogue no. 15). Additional paratypes: San Luis Potosí, 16 miles west of El Naranjo, 8 September 1992, Wes Bicha (9 males, 3 females); same but 9 Sept. 1992, Wes and Fred Bicha (15 males, 4 females); Tamaulipas, Rancho del Cielo, near Gomez Farias, 3 July 1989, R. Jones (5 males, one without terminal segments); same, about 7 miles (11.2 km) west of Gomez Farias, 6-7 July 1986, Jones and Kovarik (1 male); Hidalgo, 22 miles (35.2 km) by road northeast of Jacala, 5300 ft. (1615 m), 27 August 1972, G. W. Byers and R. Thornhill (1 female; GWB no. 16). The type locality in San Luis Potosí is approximately 14 km northeast of Ciudad del Maíz. El Naranjo does not appear on most maps of Mexico. It is on Highway 80, the road from Antigua Morelos (on Highway 85, the Interamerican Highway) to Ciudad del Maíz, and is approximately 29 km west of Antigua Morelos,

where a road turns north to Salto de Agua (known locally as El Salto). Holotype, allotype and 4 male, 4 female paratypes in the SEM; 18 males, 2 females in collection of Wes Bicha; 6 male paratypes in collection of TAM.

*Panorpa contorta* is the only Mexican species known to occur significantly below 5000 feet (approximately 1525 meters), which may relate to the fact that it is also the northernmost *Panorpa* known in Mexico.

At the type locality in San Luis Potosí, the general habitat was an oak forest in fairly high mountains (2.56 km by road southwest of the summit), with abundant epiphytic bromeliads, mosses and liverworts on the larger trees. Undergrowth included woody shrubs up to 2 m high, also low herbaceous plants .6 to 1 m high on which *Panorpa contorta* was found, together with another species of *Panorpa* as yet unnamed. The decidedly greenish *P. contorta* held its wings roof-like above the body, at rest, occasionally raising them in a "fanning" motion.

By its green color in life, its wing maculation, and by the complicated structure of the male aedeagus (Latin *contorta* = intricate, complex, twisted), *P. contorta* shows close similarity to *P. involuta* of Veracruz. It differs from *involuta* and other related species in details of the aedeagus and conformation of the hypovalves, in the male, and the broadly bilobed subgenital plate and characteristic genital plates, in the female.

#### *Panorpa ramosa* new species

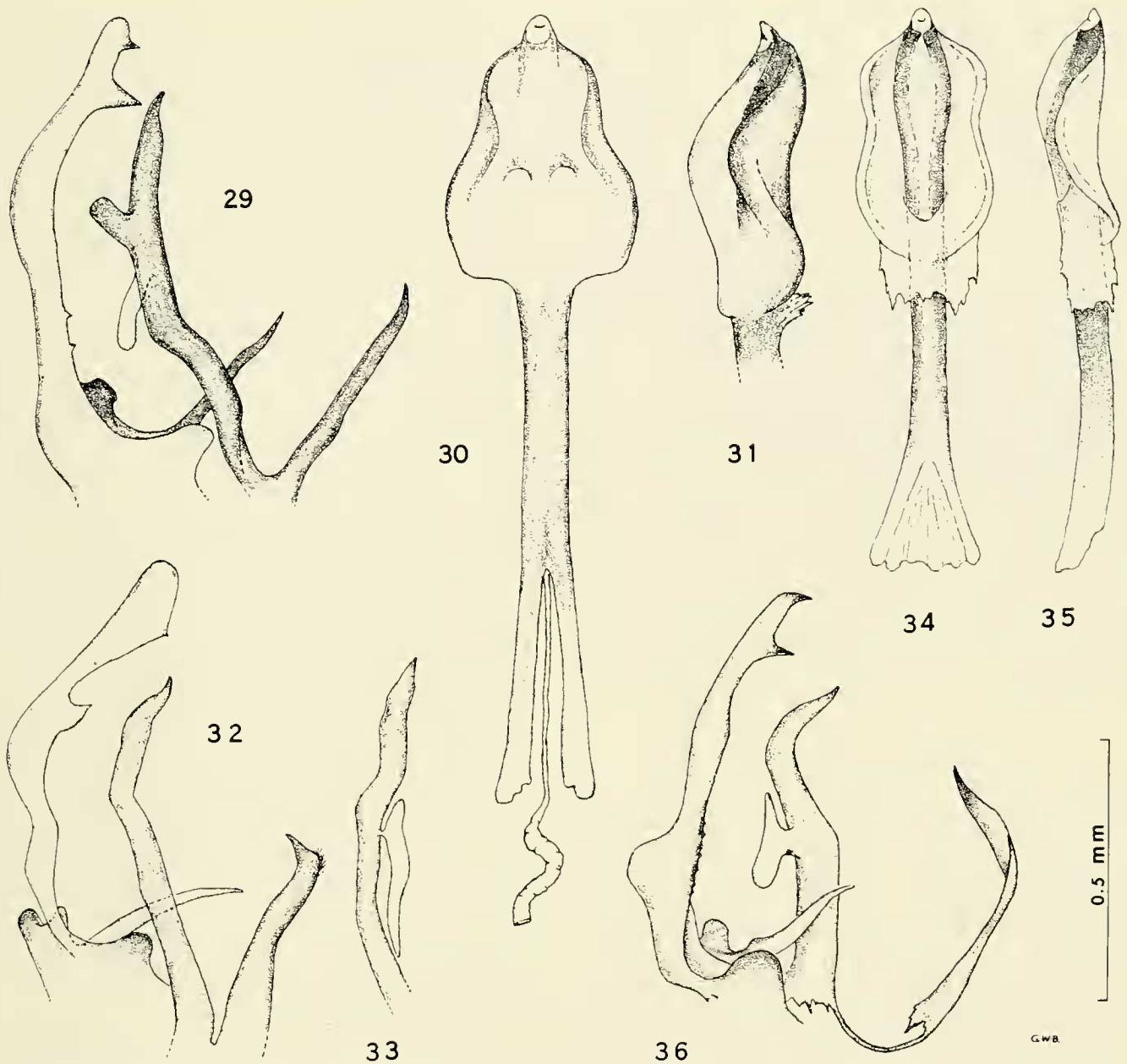
Description based on one male, two females, preserved in alcohol.

*Head:* Dorsum pale yellowish brown to tan with appressed black hairs; black around ocelli; rostrum pale yellowish brown, unmarked, with numerous erect, black hairs. Mouthparts yellowish brown; apical half of terminal segment of maxillary palp and all of terminal segment of labial palp dark brown. Antennal scape pale tan, pedicel brown, flagellum black with 37 (holotype) or 38 flagellomeres.

*Thorax:* Pronotum light tan variegated with brown, almost white at lateral edges; six (male) to eight (female) conspicuous black setae and numerous smaller ones at each side along anterior margin; short black setae on posterior margin. Dorsum of cervix light brown in females, gray in male. Mesonotum and metanotum pale tan with irregular light brown shading along each side; numerous recumbent black setae on scutum and scutellum, directed caudad. Pleural surfaces, coxae and mera pale tan with scattered, mostly pale hairs, but hairs darker on anterior surfaces of coxae. Femora and tibiae pale yellowish gray with black setae; tarsi slightly darker, apical tarsomere dark brown to black, setae black; basitarsus nearly as long as tarsomeres 2-5 together.

Wings hyaline, very lightly tinged with gray-brown, iridescent, with dark brown markings; apical spot (or band) approximately from end of  $R_2$  to end of  $M_1$ ; pterostigmal band roughly triangular, its short base along costa, covering proximal half of stigma, apex at or near  $M_1$ ; outer half of stigma light brown.

*Abdomen of male:* Terga 2-5 pale yellowish gray medially, irregularly darker gray at sides; corresponding sterna extremely pale gray, nearly white; pleura white (but see note on color in discussion); segments 6-9 yellowish brown. Notal organ weakly developed, with slight, wide backward extension of tergum 3 bearing downcurved, black setae; small, median elevated point on tergum 4. Genital bulb (Fig. 18) elongate and narrow. Hypovalves short, slender, deeply separated. Tergum 9 narrowed before level of cerci, apically bilobed; lobes broad, rounded, slightly darkened at apex (Fig. 19). Basistyles separated ventrally less than half their length,



**Figs. 29-31.** *Panorpa ramosa* n. sp. 29, aedeagus of male holotype, left lateral aspect. 30, genital plates, female, ventral aspect. 31, genital plates, female, anterior apodemes omitted, right lateral aspect. **Figs. 32-35.** *Panorpa attenuata* n. sp. 32, aedeagus of male holotype, left lateral aspect. 33, dorsal branch of left ventral paramere, ventral aspect. 34, genital plates, female, ventral aspect. 35, same, right lateral aspect. **Fig. 36.** *Panorpa reclusa* n. sp., aedeagus of male holotype, ventral parameres (both branches) removed from left or near side. Scale, all figures.

each with group of black setae on inner, postero-ventral margin. Outer margins of dististyles slightly concave before mid-length, strongly curved in distal one-third to darkly sclerotized tips; basal cup of dististyle elongated ventro-mesally, shallowly concave (Figs. 18, 20), with four long, black setae on caudal surface; mesal margin of dististyle bearing acute point normally concealed in ventral aspect. Ventral parameres (Fig. 29) biramous, lower branches curved mesad, their tips crossing; dorsal branches sinuous, acutely tipped, each extending caudad alongside respective dorsal para-

mere, with bluntly rounded lobe projecting dorsad and nearly transparent, pendulous branch directed basad. Dorsal parameres elongate, paler than ventral parameres, each with two subapical spines, or "teeth", on ventral surface, basal one larger; two tiny ventral spines near base. Ventral valves elongate, slender, darkened toward acuminate tips; dorsal valves short, rounded, darkly sclerotized.

*Abdomen of female:* Terga yellowish brown to brown, sterna 2-7 pale gray, nearly white. Irregular dark spot from each side of ter-



gum 1 down over pleuron to metathoracic meron. Subgenital plate (Fig. 21) widest near mid-length, bilobed at apex with median emargination broadly U-shaped. Genital plates (Figs. 30, 31) unusually long for genus, axial portion projecting beyond apical plate, sides of basal plate strongly curved in lateral aspect (Fig. 31); anterior apodemes about ten times as long as width of portion posterior to separation, only slightly divergent.

*Measurements:* Body length, male holotype, about 14.2 mm, female allotype 13.8 mm, female paratype 9.9 mm (but possibly deformed by damage when collected); fore wing, male, 12.7 mm, female 12.7 (allotype) to 12.8 mm. Antennal length, male, about 11.3 mm, female, about 11.6 mm.

*Types:* Holotype male, allotype female and one female paratype all collected near highway 105, 4.4 km northeast of Tlanchinol (about 98 km NNE of Pachuca), Hidalgo, Mexico, on 6 July 1992, by J. S. Ashe (his collection no. 8). Elevation at this site is 1420 m; the habitat is cloud forest with large tree ferns, dense mosses on trees; the scorpion-flies were on low foliage. All three specimens are in the SEM.

*Panorpa ramosa* is one of several species (most of them previously undescribed) of the highlands of east-central Mexico that when alive are distinctly greenish, that color being particularly evident in the pleural areas of thorax and abdomen. In callow individuals, even sclerotized areas may be greenish, for example, the genital bulb of males, the legs, and less often the head. Dr. Ashe's field notes comment that the "original color of body was a striking lime green" which "faded in alcohol within a few hours." *Panorpa mexicana*, described by Banks (1913) as "pale yellowish," was probably one of these that was greenish prior to being preserved; the only known specimen of it is a male from "Orizaba, Mexico."

### *Panorpa attenuata* new species

Description based on one male, six females, pinned.

*Head:* Dorsum sordid yellowish brown (holotype) to medium brown; dark brown around ocelli. Rostrum and frons below ocelli dark yellowish brown (holotype) to unevenly brown, rostrum dark amber-brown at sides, palest apically; mouthparts light brown to amber-brown, apical segment of maxillary palps darkened in most individuals (not holotype). Scape and pedicel yellowish brown to brown, flagellum blackish brown to black with 37-38 flagellomeres, basal one nearly equal in length to second and third together.

*Thorax:* Pronotum dark yellowish brown, darkest on transverse folds; three or four black setae at each side on anterior margin; a few slender setae near posterior margin. Mesonotum and metanotum sordid yellowish brown, without darker markings; numerous short, recumbent setae on scutum, slightly longer at sides; few longer setae on scutellum. Pleural surfaces, coxae and tibiae unevenly yellowish brown with scattered yellow hairs, longest and most dense on anterior surfaces of coxae. Femora and tibiae yellowish brown, larger tibial setae black; tarsomeres 1-3 yellowish gray, darker than tibiae; tarsomeres 4-5 grading from gray to black near claws; trace of greenish pigment in tarsi of some individuals.

Wings moderately iridescent, lightly tinged with brown, markings brown. Apical band represented by faint, narrow marking across outer radial and medial cells with longitudinal connection in outer  $R_5$  cells; more nearly complete apical band in one female. Pterostigmal band complete but narrow and irregular, from proximal end of stigma to end of  $M_4$  (interrupted between  $M_1$  and  $M_2$  in one female). Transverse spot from  $M_3$  to tip of  $Cu_1$ , another from  $R_1$  to nygma between  $R_{4+5}$  and  $M_{1+2}$ ; wider spot from  $Cu_1$  to posterior margin at end of 1A; small spot at FRs. Whitish thyridium at FM.

*Abdomen of male:* Terga 2-5 unevenly yellowish brown, corre-

sponding sterna paler; segments 6-9 yellowish brown. Notal organ a short projection from posterior margin of tergum 3, with rounded apex and numerous downcurved hairs, and triangular peg on tergum 4 with sclerotized apex curved cephalad. Posterior half of dorsum of sixth segment concave in lateral aspect, without setae. Hypo valves (Fig. 37) short, not reaching edge of ventral connection between basistyles, slender and attenuate toward tips, separated basally by more than basal width of a hypovalve. Ninth abdominal tergum (Fig. 38) truncate or very shallowly emarginate at apex, slightly darkened at corners, with sparse dark setae on dorsum, pale, yellowish setae on margins; cerci dark gray at apex. Basistyles separated slightly more than half their length, in ventral aspect (Fig. 37); inner postero-ventral margin of each bearing about 14 thick, black setae directed mesad and beneath these a conspicuous, rounded prominence on mesal surface of basistyle. Dististyles with 6-7 long setae above basal cup (Fig. 37); outer margin slightly concave near mid-length; sharp, sclerotized point on mesal margin, concealed by basal cup in ventral aspect. Ventral parameres (Fig. 32) two-branched, ventral branches acute at apex, with small subapical tuft of short setae, their tips overlapping, projecting slightly from genital bulb; each dorsal branch bearing a pendulous, membranous appendage on mesal surface (Fig. 33). Dorsal parameres elongate, sinuous, flattened and expanded in apical one-third, with small, subapical point and larger, more proximal point on ventral margin (Fig. 32). Ventral valves yellowish (appear darker in ventral aspect), long and slender; dorsal valves dark, with rounded lobe at each side of ventral valves.

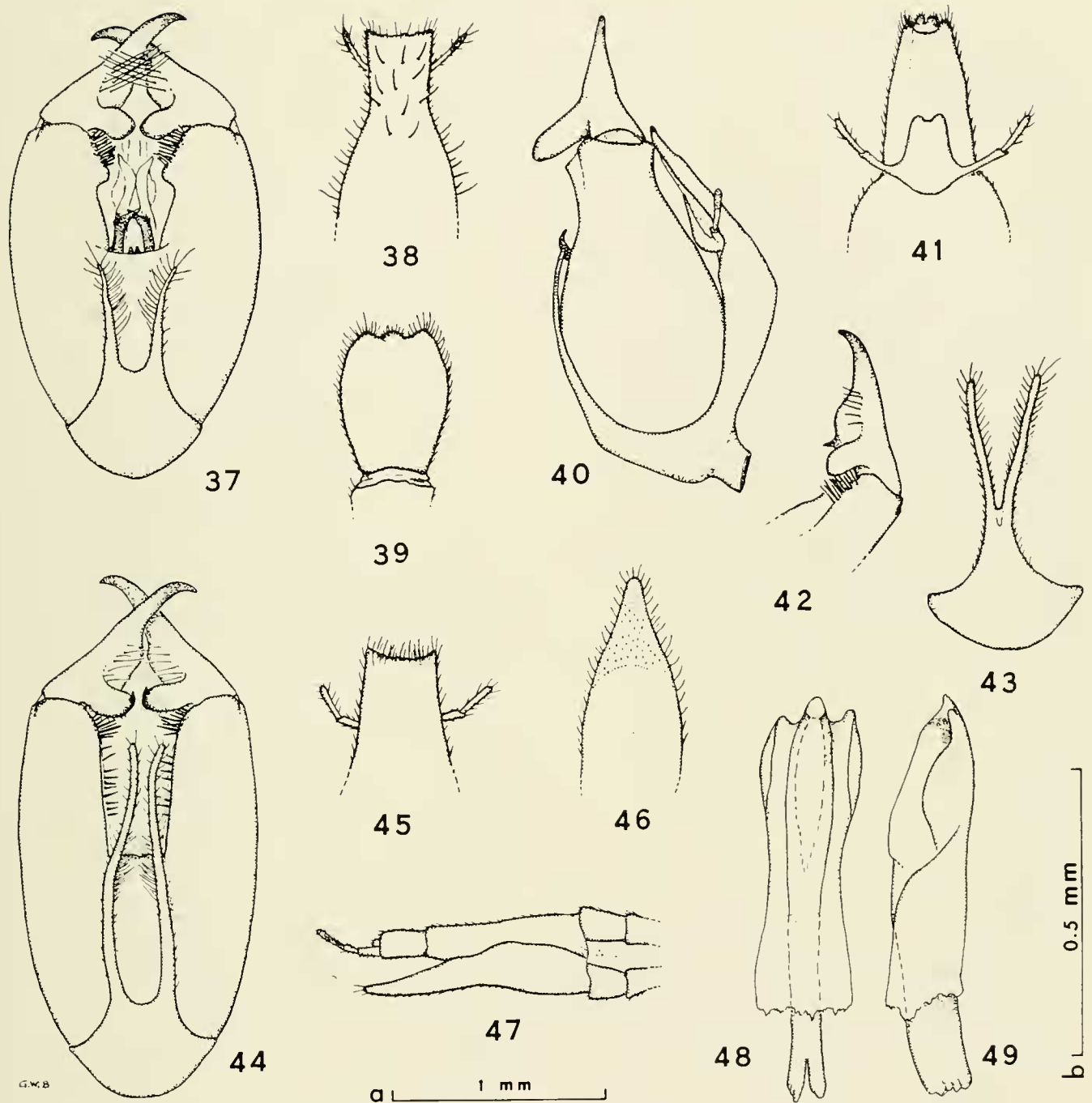
*Abdomen of female:* Terga 2-5 unevenly sordid yellowish brown, corresponding sterna paler in most females; segments 6-9 darker yellowish brown throughout. Subgenital plate widest near mid-length, unusually deep in lateral aspect, with three posterior marginal lobes, center lobe more broadly rounded than lateral ones and somewhat darkened. Genital plates (Figs. 34, 35) comprised of elongate axial portion and laterally rounded apical and basal plates (not distinctly separated); anterior apodemes divergent, but intervening region sclerotized, curved slightly ventrad anteriorly.

*Measurements:* Body length, male holotype, about 11.6 mm; female, 10.1-10.6 mm (allotype 10.1 mm). Length of fore wing, male, 11.0 mm; female, 11.3-12.6 mm (allotype 11.3 mm). Antennal length, male, about 7.8 mm, female about 10.0 mm.

*Types:* Holotype, male, allotype and five female paratypes collected beside Highway 85 (Interamerican Highway), 32 km southwest of Tamazunchale (labels say 20 mi. west), San Luis Potosí, Mexico, 19 September 1974, by W. J. Hanson and G. E. Bohart. At the suggestion of Dr. W. J. Hanson, the holotype and allotype are deposited in the SEM, and the paratypes are in the collection of Utah State University, Logan, Utah. It was also Dr. Hanson who clarified the collection site; he found, from his field notes, that he collected both *Panorpa* and *Bittacus* in second-growth forest on the slope above the highway.

*Panorpa attenuata* superficially resembles its geographically nearest neighbor species, *P. contorta* (from Hidalgo), and in wing markings somewhat resembles other species in the *involuta* species group. In several details, however, it differs from all these. Males of *attenuata* can be recognized readily by the short, attenuate hypovalves (Fig. 37), for which the species is named (Latin *attenuata* = drawn out, thin, tapered). The rounded protuberance on the mesal margin of each basistyle and the unusually long setae on the ventral surface of the dististyles are both unique among known Mexican *Panorpas*. Dissection reveals the equally unique aedeagus (Fig. 32), unlike that of *P. contorta* but showing affinity with the *involuta* species group. The subgenital plate of females of *P. attenuata* resembles that of *P. contorta* in having the posterior margin somewhat three-lobed; but the plate is widest near its posterior end and has broadly rounded lat-





**Figs. 37-39.** *Panorpa attenuata* n. sp. 37, genital bulb of male holotype, ventral aspect. 38, ninth abdominal tergum, male, dorsal aspect. 39, subgenital plate, female paratype, ventral aspect. **Figs. 40-43.** *Panorpa reclusa* n. sp. 40, genital bulb of male holotype, right lateral aspect. 41, segments 9-11, male, ventral aspect, to show apparent fusion of basal segments of cerci to small tenth segment. 42, right dististyle, male holotype, posteroventral aspect. 43, ninth abdominal sternum and hypovalves, male, ventral aspect. **Figs. 44-49.** *Panorpa mucronata* n. sp. 44, genital bulb, male holotype, ventral aspect. 45, ninth abdominal tergum, male paratype, dorsal aspect. 46, subgenital plate, female, dorsal aspect. 47, terminal abdominal segments, female, right lateral aspect. 48, genital plates, female paratype, ventral aspect. 49, same, right lateral aspect. Scale a, figs. 37-47; scale b, figs. 48, 49.

eral lobes, in *contorta*, while it narrows noticeably past its mid-length, in *attenuata*, and has more narrowly rounded lateral lobes. While no distinctly green coloration can be seen in any of the available specimens of *attenuata* (only a trace in the tarsi of two individuals), Dr. Hanson recalls the specimens as "pale green" when alive.

### *Panorpa reclusa* new species

Description based on one male, pinned.

**Head:** Dorsum yellowish brown except small ocellar triangle black; rostrum light yellowish brown, slightly darker at sides, labrum and lower clypeus retaining greenish pigment; maxillary palps yellowish brown; antennal scape yellowish brown, pedicel brown, flagellum brown, with 37 flagellomeres.

**Thorax:** Pronotum pale yellowish brown medially, darker at sides, with 5-6 conspicuous black setae at each side on anterior margin, 1-2 on posterior margin at each side of pale median band; mesonotum and metanotum uneven light brown with numerous short, black setae directed backward; pleura, coxae and mera yellowish brown, with scattered pale setae longest and most dense on anterior surfaces of coxae. Femora, tibiae and basitarsi yellowish brown, tarsomeres 2-5 slightly darker, major setae dark brown.

Wings tinged with gray-brown, with light brown markings; stigma brown; outer radial cells faintly darkened along wing margin, with diffuse brown spot from  $R_3$  to  $R_5$ , more basal diffuse spot from  $R_5$  to outer cell  $M_2$ ; pterostigmal band represented by transverse spot from base of stigma to  $M_1$ , including outer nygma, and faint spot at end of  $M_4$ ; spot extending from end of  $Cu_1$  into proximal cell  $M_3$ ; small darkening around proximal nygma, and faint spot between  $R_1$  and  $R_2$ , both slightly beyond fork of  $R_s$ .

**Abdomen of male:** Terga 2-5 yellowish brown with short yellow hairs, corresponding sterna paler; segment 6 yellowish brown, posterior half of dorsum conspicuously concave, without hairs (area contacted by genital bulb when brought fully forward); segments 7-9 paler than 6, segments 8 and 9 (genital bulb) showing traces of green pigment. Notal organ weakly developed: low, rounded median prolongation of tergum 3 with downcurved, yellow hairs, and broad peg on anterior tergum 4 with forwardly curved, sclerotized apex. Hypovalves (Fig. 43) slender, of nearly uniform width throughout, extending slightly beyond ventral connection of basistyles, borne on short prolongation of ninth sternum. Tergum 9 abruptly narrowed at level of cerci (Fig. 41), with broadly U-shaped apical emargination; tergum thickened and strongly arched dorsad near mid-length (Fig. 40). Cerci apparently fused basally to sternum 10. Basistyles separated ventrally by only about 0.4 their length, with cluster of black setae on postero-ventral edge directed mesad. Outer margin of dististyles slightly concave before mid-length; basal cup prolonged ventromesally; sharp, strongly sclerotized point on mesal margin above cup, concealed by basal cup in ventral aspect; row of setae from base of cup toward apex (Fig. 42). Aedeagus complex (Fig. 36), ventral parameres dark yellowish brown, two-branched; ventral branch with brown tip; dorsal branch acutely tipped, with pale membranous appendage prolonged conspicuously in both directions from attachment. Dorsal parameres yellowish brown with sharp apex, sharp "tooth" near apex, and numerous small teeth near base opposite rounded, dorsal prominence. Ventral valves yellowish brown, long and slender; dorsal valves darker, rounded apically.

**Measurements:** Body length, male holotype, about 10.8 mm. Fore wing length 11.9 mm. Antenna about 9.1 mm.

**Type:** Holotype, male, collected 22 miles (35.2 km) northeast of Jacala, Hidalgo, Mexico, elevation 5300 feet (1615 m), 27 August 1972, by G. W. Byers and R. Thornhill; in the SEM. The genital bulb has been dissected and is in a microvial of glycerin on the pin with the rest of the specimen.

*Panorpa reclusa* was collected together with *P. mucronata* but is strikingly different in length of hypovalves, shape of basal cup of dististyles and overall length of genital bulb; it

also differs in wing maculation. In general aspect of the genital bulb, *P. reclusa* more nearly resembles *P. contorta* of San Luis Potosí, but in details of the aedeagus it is altogether different (compare Figs. 25 and 36). No females could be associated with the male of *reclusa*, although I have six unidentified females with much more darkly marked wings, taken at the same locality in Hidalgo, in a much earlier season (mid-July). The male holotype differs in one way or another from all other species of the *involuta* group known, hence the name (Latin *reclusa* = alone, separated, removed).

### *Panorpa mucronata* new species

Description based on 15 males, 7 females, pinned, and 5 males, 7 females in alcohol.

**Head:** Dorsum sordid yellowish brown except dark brown around ocelli; rostrum and frons below antennal bases light yellowish brown; mouthparts including maxillary palps yellowish brown. Scape pale yellowish brown, pedicel brown, flagellum dark brown with 35-36 flagellomeres (holotype 35).

**Thorax:** Pronotum light yellowish brown medially and at sides, brown dorsolaterally, especially on transverse ridges; 5-7 black setae at each side on anterior margin. Mesonotum and metanotum mainly light grayish brown, darker brown at sides before wing bases, covered with numerous short, black setae directed backward, but no large setae. Pleural surfaces, coxae and mera unevenly yellowish brown (variation due to post-mortem changes in drying), with scattered pale setae longest and most numerous on anterior surfaces of coxae. Femora pale yellowish brown (with faint greenish tinge in some specimens); tibiae and tarsi darker yellowish brown; basitarsus as long as tarsomeres 2-5 together in fore and middle legs, longer than 2-5 in hind legs.

Wings faintly tinged with grayish brown, markings light brown to brown. No complete bands and few spots; fore wings of males either with no distinct markings (e.g., holotype) or: diffuse clouding across outer cells  $R_3$  to  $M_1$ ,  $P_{1b}$  represented by spot at distal end of stigma and irregular spot from proximal end of stigma to  $M_{1+2}$  including outermost nygma, small spot from  $R_1$  to  $R_{2+3}$  near level of FM, small spot at ORs and spot between  $Cu_1$  and  $Cu_2$  midway between cubital cross-veins. No dark borders along radial or medial cross-veins. Fore wing of female similar to that of more darkly marked males but often with spot at end of  $Cu_1$  and faint spot at end of  $M_4$ .

**Abdomen of male:** Terga 2-5 unevenly yellowish brown with short, pale setae; corresponding sterna only slightly paler; segment 6 yellowish brown, its posterodorsal one-third somewhat concave, without setae (genital bulb contacts this surface when brought fully forward); segments 7-8 short; genital bulb (Fig. 44) elongate, pale grayish brown to tan, with greenish tinge in some males. Notal organ weakly developed: low, broadly rounded projection with downcurved, yellowish hairs, on tergum 3, and small peg with sclerotized, sharp tip curved cephalad, on tergum 4. Hypovalves (Fig. 44) unusually elongate, slender, extending nearly to ends of basistyles, separated basally by twice width of a hypovalve, or more, with yellowish hairs generally sparse but longer and much more dense near mid-length on mesal surface. Tergum 9 (Fig. 45) gradually narrowing toward apex, arched away from basistyles near its mid-length so much of dorsal parameres can be seen in side view; apex of tergum very slightly emarginate to truncate. Basistyles separated only about 40 per cent of their length in ventral aspect. Inner, posteroventral margin of each basistyle bearing 8-10 black setae directed mesally; similar setae on inner surface of basistyle in irregular diagonal row more dorsal at basal end. Outer margins of dististyles slightly concave near mid-length, evenly curved to strongly sclerotized tip; basal cup of dististyle shallowly concave on lower (anterior) surface, longer than wide, with strongly sclerotized apical margin slightly upturned to small mucronate point in most males (11 of 15; Fig. 44); (margin slightly upturned in males

lacking apical point). Inner margin of dististyle bearing sharp point concealed by basal cup in ventral aspect (cf. Fig. 42); uneven, short row of setae extending up ventral surface of dististyle from basal cup. Ventral parameres (Figs. 50, 51) two-branched, ventral branch pale yellowish but moderately sclerotized, flattened, obliquely truncate; dorsal branch yellowish, with thin, membranous dorsal margin (presumed equivalent to membranous appendage in related species). Dorsal parameres thickest at nearly 90-degree bend slightly before mid-length, well sclerotized but straw-yellow, with large, triangular, subapical "tooth" and smaller point at apex. Ventral valves short, moderately sclerotized, totally concealed in ventral aspect; dorsal valves short, bluntly rounded, well sclerotized.

**Abdomen of female:** Terga unevenly light brown to brown; corresponding sterna, particularly 2-5, somewhat paler. Subgenital plate (Figs. 46, 47) unusually elongate, prolonged posteriorly to narrowly rounded apex with dorsal surface of apical one-third well sclerotized and bearing scattered, minute setae; longer setae around margin. Genital plates small, with axial portion compressed, straight and slender in ventral aspect, thick in lateral aspect (Figs. 48, 49), with anterior apodemes turned slightly dorsad, not darkly sclerotized; length of apodemes variable; apical plate curved ventrad at sides, pale yellowish brown; basal plate only weakly developed, curved closely around axial portion, its anterior margin indistinct.

**Measurements:** Body length (based on pinned specimens), male, about 8.8-12.5 mm (holotype 9.9 mm); female, 9.2-10.3 mm (allotype 9.0 mm). Length of fore wing, male, 11.0-11.9 mm (holotype 11.4 mm); female, 10.6-11.9 mm (allotype 11.9 mm). Antennal length, male, about 8.5 mm, female about 8.4 mm.

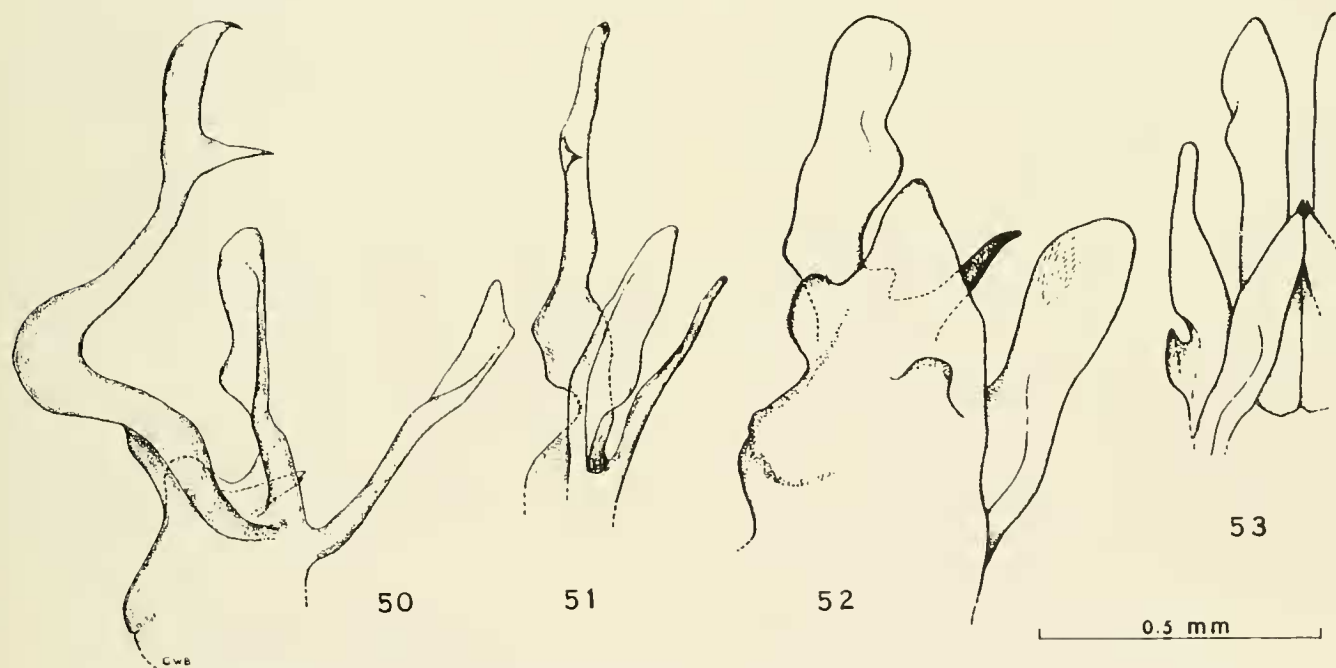
**Types:** Holotype, male, collected beside Highway 85 (Inter-american Highway) at El Ocote vicinity, 22 miles (35 km) by road northeast of Jacala, Hidalgo, Mexico, elev. 5300 ft. (1618 m), 27 August 1972, by G. W. Byers and R. Thornhill (GWB field cat. Hidalgo no. 16). Allotype, female, and 3 male, 1 female paratypes same data as holotype. Additional paratypes: 10 males, 10 females, same locality as holotype, 18 July 1963, G. W. Byers (cat. no. 11);

2 males collected at Minas Viejas, Hidalgo, 4 August 1966, by O. S. Flint, Jr., and M. Ortiz. Holotype, allotype and most paratypes are in the SEM; 2 paratypes in the USNM.

The habitat at the type locality was the edge of a forest of various broad-leaved trees (mainly oaks, beech, alder), at the foot of a north-facing slope, with underbrush of brambles, thorny vines, bracken-like ferns and scattered patches of herbaceous plants. The *Panorpas* were found on the broad-leaved herbaceous plants or less often on brambles, 2-3 feet above the ground, at edges of open areas but in places that would have been shaded on a sunny day. (It was 100% overcast, foggy and a cool 70°F when the first collection was made, 67° the next.) *P. mucronata* appeared to be early in its season of emergence on 18 July, as some individuals were callow on that date (therefore preserved in alcohol). When at rest, *P. mucronata* holds its wings roof-like above the body, that is, not flat and overlapped.

When alive, this species has a bright green color, particularly evident on the thoracic and abdominal pleura (see comments under *Panorpa involuta*), which fades rapidly in alcohol-preserved specimens and in a few hours or days in dried specimens.

Males of *Panorpa mucronata* can be recognized readily by the long, slender, deeply divided hypovalves and, usually, by the mucronate tips on the basal cups of the dististyles, for which the species is named. A male lacking the sharp tips on the basal cups of the dististyles was dissected, and the aedeagus characteristic of the species was also found in this male. The obliquely truncate ventral branches of the ventral parameres can usually be seen in an intact, dried in-



**Figs. 50-51.** *Panorpa mucronata* n. sp. 50, aedeagus, male paratype, left lateral aspect. 51, left half of male aedeagus, ventral aspect. **Figs. 52-53.** *Panorpa bimaculata* n. sp. 52, aedeagus, male paratype, left lateral aspect. 53, left half of aedeagus, ventral aspect. Scale, all figures.



dividual. Females are also easily recognized by the unique elongate and narrow-tipped subgenital plate.

### Key to Species in the *Panorpa involuta* group

1. Wing pattern of two spots: a triangular, dark brown pterostigmal spot from C to near  $M_1$  and an uninterrupted, dark brown apical spot or band from  $R_2$  to  $M_1$ ; wing otherwise clear ..... *ramosa*
- Wing pattern with more than two spots or bands or without distinct markings ..... 2
2. Pterostigmal band (ptb) complete from C to hind margin; apical band divided by clear area into two transverse, curved bands, one along apical margin, one more proximal; two additional large spots between ptb and wing base, one at posterior margin, one near costal margin; hypovalves of male slender, about 8 times as long as basal width, borne on subtriangular extension of ninth sternum ..... *mexicana* Banks
- Pterostigmal and apical bands fragmented (or ptb complete in some females of *P. involuta*, with more than two spots between ptb and wing base) ..... 3
3. Male hypovalves (hv) deeply separated, long (about 12-13 times as long as basal width), extending far beyond connection between basistyles; basal cup of dististyle with strongly sclerotized mesal margin, usually with upturned point; subgenital plate of female narrowed and prolonged backward, with narrowly rounded apex ..... *mucronata*
- Male hv short, not reaching edge of connection between basistyles or only slightly beyond edge; subgenital plate of female not narrowly rounded at apex ..... 4
4. Male hv short, slender, curving apart and each tapering to narrow apex; inner margin of basistyle conspicuously indented; subgenital plate of female oval in outline, shallowly notched apically ..... *attenuata*
- Male hv extending to or slightly beyond connection between basistyles, if slender not attenuate toward apex; subgenital plate of female widened posteriorly (female of *P. reclusa* unknown) ..... 5
5. Male hv deeply separated; ninth sternum bearing hypovalves not conspicuously prolonged beneath genital bulb; subgenital plate of female with small median projection in emargination between broadly rounded apical lobes ..... *contorta*
- Male hv borne on narrow prolongation of ninth sternum; subgenital plate of female broadly rounded apically (*involuta*) ..... 6
6. Male hv shorter than prolongation of ninth sternum (ventral aspect); aedeagus as Figs. 22, 23; subgenital plate of female broadly rounded apically ..... *involuta*
- Male hv longer than prolongation of ninth sternum (ventral aspect); aedeagus as Fig. 36; female unknown ..... *reclusa*

### *Panorpa bimaculata* new species

Description based on 65 males, 44 females, pinned, and 14 males, 46 females preserved in alcohol.

**Head:** Dorsum dark yellowish brown except brownish black around ocelli; rostrum yellowish brown at sides and medially, with two amber brown vertical (longitudinal) stripes. Mouthparts amber brown; terminal segment of maxillary palps dark brown. Antennal scape light yellowish brown, pedicel brown; flagellum black, with 42 to 47 flagellomeres (42 on left side, 43 on right side in holotype).

**Thorax:** Pronotum yellowish brown medially and at sides, with two irregular, broad black spots or longitudinal bands intervening; anterior margin strongly upturned, with 9-12 conspicuous marginal black setae and numerous shorter black setae at each side. Mesonotum black at each side, with broad yellowish brown to light brown median band continuous with pale medial portion of pronotum and gradually widening posteriorly to include entire scutellum. Numerous short, recumbent black setae on most of mesonotal surface. Metanotum sordid yellowish brown medially, with large, diffuse black spot at base of each hind wing; setae paler and more sparse than those of mesonotum. Pleural surfaces, coxae and mera unevenly yellowish brown, with setae darkest and most dense on anterior surfaces of coxae. Ventral tips of mesothoracic and metathoracic mera diverging slightly from respective coxae. Femora and tibiae yellowish brown with encircling rows of dark, appressed setae; tarsi slightly darker than tibiae; larger setae of tibiae and tarsi black.

**Wings** (Fig. 99b) mostly hyaline, with two conspicuous dark brown or grayish brown spots on each, one terminal, one pterostigmal. Extent of spots variable even among wings of one individual; pterostigmal spot often extending back to nygma between veins  $R_5$  and  $M_1$ . Small, weak spot on vein  $M_4$  in fore wings of some individuals (e.g., holotype); less often a small spot in second cell  $Cu_1$  of fore wing. Numerous dark microsetae in nearly all cells of fore wing, on upper surface.

**Abdomen of male:** Segments 2-5 unevenly yellowish brown, segments 6-9 darker yellowish brown. Segments 7 and 8 short, thick. Notal organ a slightly elevated and extended, broadly rounded caudal margin on tergum 3, with downcurved, yellow setae, and a small, median peg (normally concealed) on tergum 4. Hypovalves of ninth sternum (Fig. 54) short, slender, divergent from common stem, with conspicuous yellow hairs along mesal margin of distal two-thirds of each. Tergum 9 narrowed beyond level of projecting cerci, weakly bilobed apically (Fig. 55). Outer margins of dististyles, in ventral aspect, slightly concave in basal half, slightly convex in apical half except more strongly curved close to darkly sclerotized apex. Basal cup of dististyle shallowly concave on anterodorsal surface; ventral margin with long, yellow hairs. Ventral parameres (Figs. 52, 53) pale, compressed, rounded apically, inclined together with apices in contact. Dorsal parameres similarly pale, enlarged, rounded apically. Ventral valves of aedeagus dark, slender, with acute tips. Lateral processes large, conspicuous in ventral aspect.

**Abdomen of female:** Terga 2-6 dark yellowish brown (often with uneven post-mortem darkening), corresponding sterna paler yellowish brown. Segments 7-10 evenly dark yellowish brown. Subgenital plate of sternum 8 (Fig. 56) broadly rounded apically, with shallow median notch and about ten large, dark setae on or near margin at each side of notch (9 and 10 in allotype), lateral setae shorter, paler. Genital plates (Fig. 68) reduced to thick, nearly straight axial portion with hyaline apex, anterior apodemes moderately divergent; apical plate rounded posteriorly at each side, only weakly developed anteriorly; basal plate not evident.

**Measurements:** Body length (based on pinned specimens), male, 9.3-11.8 mm (holotype 11.2 mm); female, 10.1-13.8 mm (allotype 11.0 mm). Length of fore wing, male, 12.6-14.1 mm (holotype 13.9 mm); female, 13.0-15.2 mm (allotype 13.2 mm). Antennal length, holotype, about 11.8 mm; allotype about 11.0 mm.

**Types:** Holotype, male, allotype and 22 male, 12 female paratypes, pinned, and 4 male, 32 female paratypes in alcohol, collected at El Tejocote, highway 190, at km 141 (about 50 km northwest of city of Oaxaca), elevation 2320 m, state of Oaxaca, Mexico, 4 August 1969, by G. W. Byers (field catalogue Oaxaca no. 10); in the SEM. Additional paratypes: same locality but 5 August 1969 (field cat. no. 12), 13 males, 8 females pinned, 6 males, 10 females in al-

cohol (SEM, USNM, MCZ and UMMZ); essentially same locality (labels read "Tejocates"), 4 August 1965, O. S. Flint and M. Ortiz (7 males, 5 females; USNM); same locality (labels read "Tejocates"), 8 June 1967, O. S. Flint, Jr. (5 males, 7 females; USNM, SEM); Oaxaca, 3 km south of El Marques, 1 July 1990, Wes and Fred Bicha (12 males, 7 females; SEM and WB); same locality, 3 July 1990, Wes Bicha (8 males, 4 females; WB); same locality, 18 August 1993, Wes Bicha (1 male; WB); Oaxaca, 15.1 mi. N of San Gabriel Mixtepec, Hwy. 131, 3850 ft., 11 July 1987, R. Wharton (1 female; TAM); Oaxaca, Las Animas, 1 mi. N of El Punto, 7400 ft., 17 July 1987, R. Wharton (2 females; TAM); Puebla, 4.7 mi. SW of La Cumbre, 5100 ft., R. Wharton (1 female; TAM).

*Panorpa bimacula* was found together with *P. immaculata* Esben Petersen in shaded, low, broad-leaved herbaceous plants growing on fairly level ground near the highway (at El Tejocote) or low on nearby slopes, which were steep and wooded with oaks and some pines. Both species of *Panorpa*, I noted, remained near the ground, usually below 30 cm, uncommonly up to 45 cm, rarely to 60 cm. Several individuals were captured by hand in vegetation only 5-6 cm high. There was occasional light rain during the first collecting period, which may have influenced this behavior. The next day, the rain having ended, some of the *Panorpas* were higher in the vegetation (up to about 90 cm), although most were still found relatively near the ground. Again, a preference for broad-leaved plants was noted, the scorpionflies were never on nearby ferns or grasses.

The species takes its name (Latin *bi* = two, *macula* = spot) from its easy recognition characteristic, two conspicuous spots on each wing, but also from the two dark spots on the pronotum, two each on the mesonotum and metanotum and the two elongate spots on the front of the rostrum. At least four other Mexican species of *Panorpa* have some degree of gray coloration at the wing tips; these are *P. terminata* Klug, *P. penicillata* Byers, *P. ramosa* and *P. sarta*, new species described herein. (There may be others, as yet undiscovered.) *Panorpa terminata*, however, rarely has any gray pigmentation near the pterostigma (a thin, weak, transverse subrescenscent spot near base of stigma seen in two females). Males of *P. sarta* can easily be differentiated from those of *bimacula* by the elongate genital bulb with long, slender prolongation of the ninth sternum reaching the ends of the basistyles and only slightly divided near its apex (Fig. 57). *Panorpa penicillata* has no pattern of pigmentation on the thoracic dorsum, and males of this species have a small, setiferous branch on the ventral surface of each hypovalve and have the ninth abdominal tergum deeply bilobed. While *P. bimacula* is so far known only from Oaxaca, *terminata* occurs farther north (Morelos), and *penicillata* in the western mountains of Durango. *P. ramosa*, known only from Hidalgo and *P. sarta* from Michoacán, differ from *bimacula* in several characteristics as discussed in the sections on these species.

### *Panorpa sarta* new species

Description based on 16 males, 11 females, pinned.

**Head:** Dorsum yellowish brown; diffuse brown spot on vertex at edge of each eye, usually a light brown spot between this and piceous ocellar triangle; lateral ocelli 1.3 times as wide as median ocellus. Rostrum yellowish brown medially, darker at sides; mouth-

parts amber-brown except maxillary palps unevenly yellowish brown. Antennal scape pale yellowish brown, pedicel wholly or partly brown, flagellum brown to almost black, with 38-44 flagellomeres.

**Thorax:** Pronotum mostly black, pale yellowish along posterior margin and small median spot on anterior margin; 9-10 black setae at each side on anterior margin. Mesonotum and metanotum with broad, pale yellowish brown band medially, with numerous short, black hairs directed caudad; dark brown to nearly black at sides except small pale spot near wing base in most individuals. Pleural surfaces, coxae and mera unevenly pale yellowish brown with numerous short, dark setae on anterior coxa and on mesothoracic coxa and episternum; sparse, pale setae on metathorax, most numerous on coxa; small, intensely black spot at each end of mesepimeron and lower end of metepimeron. Femora and tarsi yellowish brown, tibiae slightly paler, all with yellowish hairs but major setae black.

Wings faintly tinged with gray-brown, slightly iridescent, stigma dark yellowish, apical spot brown, most veins brown, some outer cross-veins, humeral cross-vein, basal stem of Cu and thyridium at first fork of M white; abundant microsetae in all cells of fore wing; apical spot variable in extent, usually from  $R_2$  to  $M_1$ .

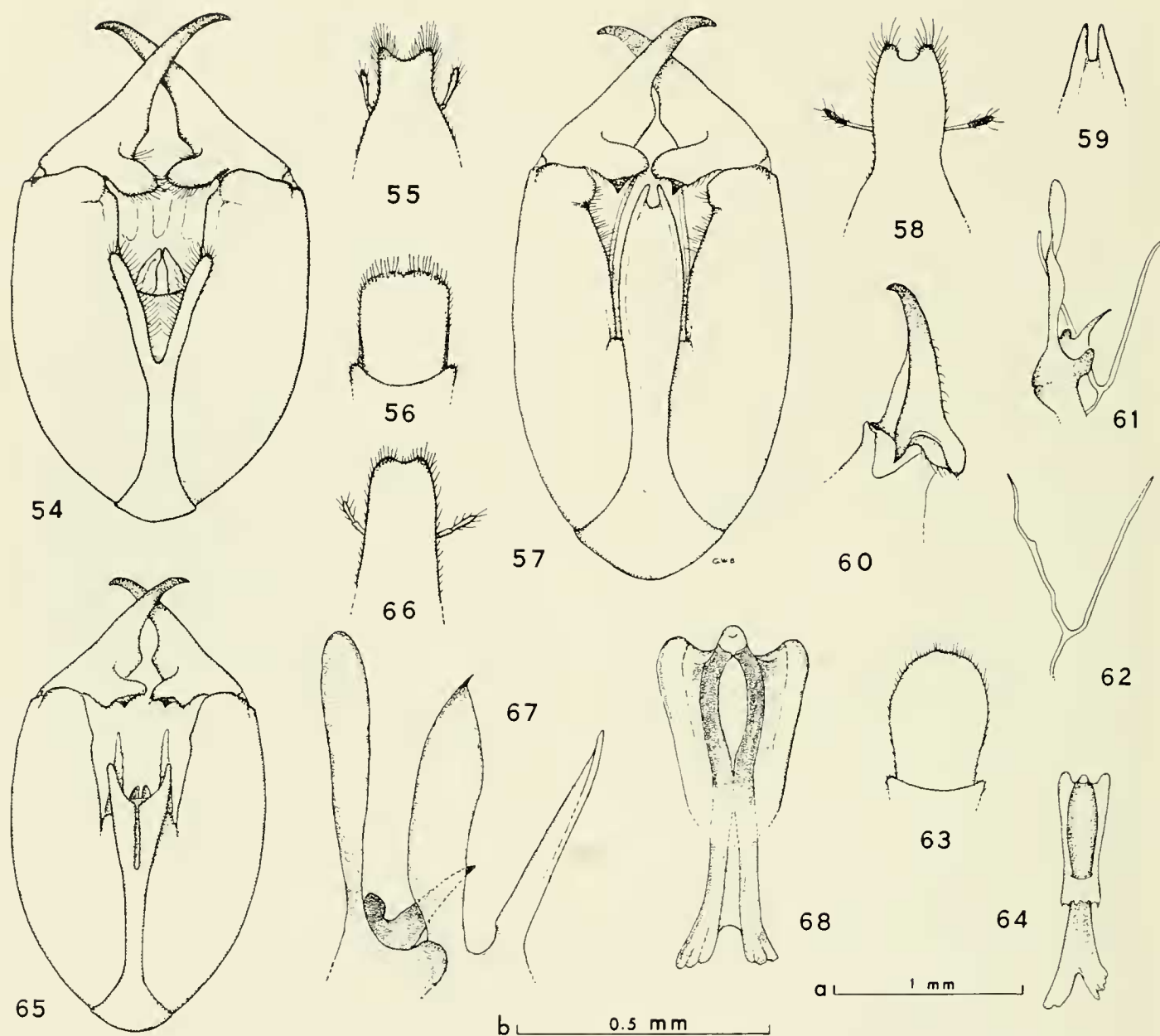
**Abdomen of male:** Terga 2-5 unevenly yellowish brown, corresponding sterna slightly paler; segment 6 yellowish brown with abundant short, pale setae. Notal organ a broadly rounded, slight median prolongation of tergum 3 with downcurved, yellowish hairs, and roughly triangular prominence on tergum 4 with strongly sclerotized apex curved cephalad. Segments 7-8 short, together about as long as 6, yellowish brown. Genital bulb elongate, including dististyles nearly as long as head, dark yellowish brown. Hypovalves (Fig. 57) extending to ends of basistyles, fused nearly their complete length, producing structure somewhat thickened along outwardly curved sides, thin and translucent between; depth of apical notch and width of combined hypovalves variable. Ninth tergum (Fig. 58) with rounded apical lobes separated by shallow emargination; cerci with only one exposed segment, slender basally, expanded and darkened apically. Basistyles separated ventrally less than half their length. Outer margins of dististyles straight until subapical curvature to strongly sclerotized tip. Basal cup of dististyle (Fig. 60) projecting ventro-mesally, underside shallowly concave, densely sclerotized at apical margin, along dorsal margin and onto acutely pointed projection on dorsal edge of cup (apparently homologous with sclerotized point more removed from basal cup in some other Mexican species). Ventral parameres (Figs. 61, 62), yellow, two-branched, both branches long, slender except for slight widening near mid-length of dorsal branch; ventral branches approximately parallel to edges of fused hypovalves. Dorsal parameres elongate, flattened, rounded at apex, twisted near mid-length, yellowish but moderately sclerotized. Ventral valves slender, acutely tipped, moderately sclerotized; dorsal valves short, bluntly rounded at apex.

**Abdomen of female:** Terga 2-9 mostly unevenly brown with diffuse, narrow, paler median stripe; sterna much paler than corresponding terga; segment 10 light brown, cerci black. Subgenital plate (Fig. 63) broadly rounded at apex, with only pale hairs. Genital plates (Fig. 64) only slightly expanded from axial portion; apical plate with narrowly rounded posterior lobes; basal plate indistinct, mostly membranous; anterior apodemes moderately divergent, much paler than posterior part of axial structure.

**Measurements:** Body length, male, about 10.2-13.2 mm (holotype 11.0 mm); female, about 11.9-13.5 mm (allotype 13.1 mm). Length of fore wing, male, 13.3-14.4 mm (holotype 14.1 mm); female, 13.0-14.2 mm (allotype 13.9 mm). Antennal length, male, about 10.8 mm, female, 10.5 mm.

**Types:** Holotype, male, allotype female and 12 male, 10 female paratypes collected 16.4 miles (26.2 km) east of Morelia, Michoacán, Mexico, elevation 7000 ft. (2134 m), 9 August 1963, by George W. Byers (GWB field catalogue Michoacán no. 1); 3 male paratypes, Michoacán, jct. Hwy. 4 and Huetano Road, 5 miles (8 km) east of Morelia, 2100 m, 8 July 1947, T. H. Hubbell no. 83 (earlier misidentified by me [Byers, 1958] as *P. terminata*). Holo-





**Figs. 54-56, 68.** *Panorpa bimacula* n. sp. 54, genital bulb, male paratype, ventral aspect. 55, ninth abdominal tergum, male, dorsal aspect. 56, subgenital plate, female, ventral aspect. **Figs. 57-64.** *Panorpa sarta* n. sp. 57, genital bulb, male holotype, ventral aspect. 58, ninth abdominal tergum, male, dorsal aspect. 59, apex of fused hypovalves, showing variation from Fig. 57. 60, right dististyle and apex of basistyle, mesal aspect. 61, aedeagus of male, left or near ventral paramere removed, left lateral aspect. 62, ventral paramere, left lateral aspect. 63, subgenital plate, female, ventral aspect. 64, genital plates, female, ventral aspect. **Figs. 65-67.** *Panorpa terminata*, male from Morelos, Mexico. 65, genital bulb, ventral aspect. 66, ninth abdominal tergum, dorsal aspect. 67, aedeagus, left lateral aspect. Scale a, figs. 54-66; scale b, figs. 67, 68.

type, allotype and most paratypes are in the SEM. Paratypes also in USNM, UMMZ and collection of WB.

The type locality is a mountain pass, the Puerto Presidente Ortiz Rubio, on Highway 15. The general habitat was pine forest with occasional oaks, underbrush of *Baccharis*, small oaks, thorny leguminous shrubs, some patches of *Rubus*, wide

patches of flowering *Lythrum*, etc. The *Panorpas* were on broad-leaved herbaceous plants growing on relatively flat "terraces" on the slope. Three species of *Panorpa* were present and in such numbers that 32 were collected in half an hour before a downpour of rain ended collecting; sky overcast, temperature 67°F.



Superficially, *P. sarta* closely resembles *P. terminata* but is slightly larger and darker; the similarity is particularly in the wing markings and pale median stripe on the thorax. The slight separation of the hypovalves occurs also in *P. immaculata* Esben Petersen, but in that species the prolongation of sternum 9 is extremely slender and does not give the impression of fused hypovalves, rather only short ones on a long pedicel; and its wings are unmarked. While males of *P. sarta* can readily be distinguished from those of any other species by the long, fused hypovalves (Latin *sarta* = joined, connected), females are not as easy to differentiate from *terminata*, *ramosa* or *bimacula*, species with similar wing markings. Identification may require dissection.

### *Panorpa terminata* Klug

This is a common species in Morelos, Mexico, but I have not collected it in other parts of the country. Many years ago (Byers, 1958) I identified three specimens collected in Michoacán by T. H. Hubbell as *terminata*, but I have recently re-examined them and they belong to the species *P. sarta* described above. When I compared a female of *sarta* with the female types of *terminata*, I noted that my specimen was somewhat larger and had more darkly marked wings than typical *terminata*.

The male of *P. terminata* has never been described. In addition to the characteristic wing markings, it has hypovalves that set it apart from other species (Fig. 65); borne on a slender pedicel, they widen to slightly beyond mid-length, then narrow toward the tips. Tergum 9 (Fig. 66) has two rounded and somewhat darkened apical lobes separated by a shallow emargination. The aedeagus (Fig. 67) is unlike that of any other species, particularly in the shapes of the dorsal parameres and the dorsal branch of the ventral parameres.

On 29 and 30 July 1963, I collected numerous individuals of *P. terminata* in early morning and late afternoon, at a site about 23 km by road north of Cuernavaca, elevation 2225 m. It seemed this species spent much of the day very low in the vegetation or on the ground. No *Panorpas* were observed at this site between 2 and 5 p.m., and only three were found in two hours of general collecting, 9-11 a.m. However, before 9 a.m. and after 5:15 p.m. they were commonly seen and netted about 45-60 cm above ground surface, on broad-leaved herbaceous plants and bunch-grasses shaded by oak and pine trees. On another occasion, I noted that when the sky was totally cloudy-overcast, the *Panorpas* were more active in the vegetation during the day, but when suddenly alarmed they flew to the ground, or near it, not to other leaves well above the surface.

This species' original description (Klug, 1836: 106, fig. 10) was based on three female specimens, all of which are still present in the collection of the Zoologisches Museum, Humboldt University, Berlin. All three have green labels reading "Mexico, Deppe." Two are also labelled "*Panorpa terminata* Kl." and, on a small red tag, "Type," and the third has the red type label and a small label with the printed number "237." The number 237 refers to an entry for *Panorpa*

*terminata* Klug (3 Ex., Mexico, Deppe) in the "Catalogus Generalis Musei Zoologici Berolinensis, Band Neuroptera." I am indebted to Dr. K. K. Günther for this information. One of the syntypes has had the wings spread (photo in the monograph by Esben-Petersen, 1921: 71, fig. 75). This female is now designated lectotype of *P. terminata* and has been so labelled. It is intact except the flagellum of its right antenna is missing, and the right hind leg and adjacent portion of the thorax have been destroyed (by dermestid?). The description accompanying Esben-Petersen's photograph is based on a specimen from Tepic, Nayarit, and probably pertains to *Panorpa penicillata*, as it mentions a "dark smoky, brown, subtriangular" pterostigmal spot extending halfway across the wing.

In the Museum of Comparative Zoology, Harvard University, there is a female specimen labelled "Hagen" and "Type, 11116" (on a red label), also "*terminata* Kl., Mexico." This is apparently not part of Klug's original type series and therefore is not a type.

There is a species in Michoacán, *P. sarta*, that in many respects closely resembles *P. terminata* in coloration of body and wings. Its dorsal thoracic pattern in particular resembles that of *terminata*. Its females are slightly larger and darker than those of the type series of *terminata*. The genital bulbs of the males, however, are quite different (compare Figs. 65 and 57). The recorded travels of the collector of *terminata*, Ferdinand Deppe, add some support to my identification of the species from Michoacán. There is no indication that Deppe travelled to the west of Mexico City beyond Toluca (see Papavero, 1971: 103), while he crossed the modern state of Morelos on various trips, 1824-1827. And in Morelos, a species that agrees with the lectotype of *terminata* in characteristics of both size and coloration is quite common, and I have so identified it.

### *Bittacus disternum* new species

Description based on 4 males, 7 females, pinned, one male in alcohol.

*Head:* Dorsum and frons unevenly brown, black around strongly protruding ocelli; diameter of lateral ocelli about 1.7 that of median ocellus. Rostrum and mouthparts dark brown; maxillary palps brownish black. Antennal scape and pedicel brown, less often yellowish brown; flagellum light brown with 21-22 flagellomeres with hairs slightly longer than diameter of respective flagellomeres.

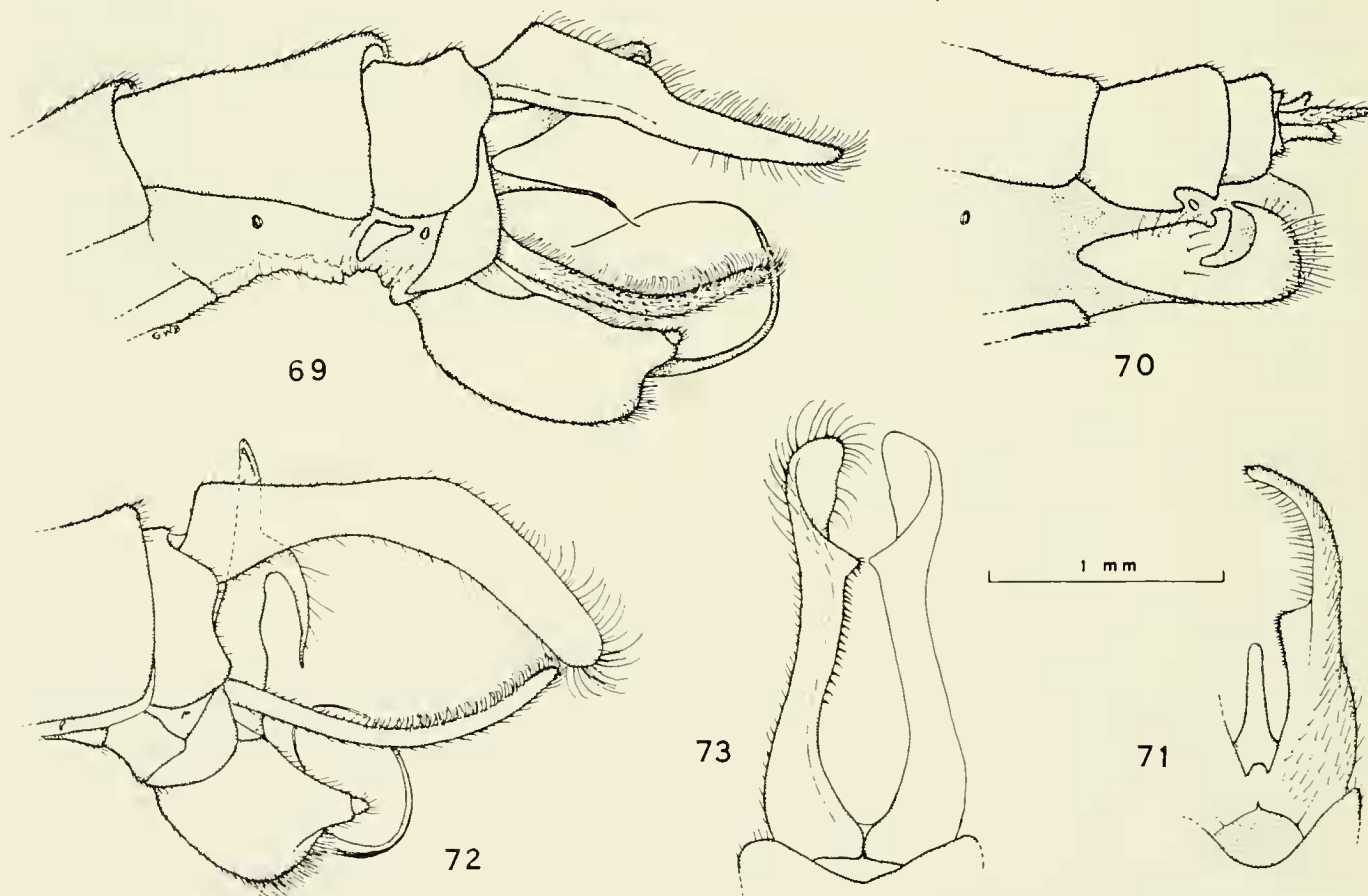
*Thorax:* Pronotum unevenly brown, lightest brown along posterior edge; four conspicuous black setae on anterior margin, one dorsolateral, one lateral, on each side (rarely double in either position), each on slight elevation; two setae on posterior margin. Anterior propleura large, discoidal, with short setae along anterior edge, extending backward beneath lateral edges of pronotum. Anterior spiracle in vertical alignment with posterior pronotal margin. Mesonotum and metanotum unevenly brown, darkest on elevated areas, with one large, black seta on mesoscutum near base of fore wing, another on uppermost pleuron just before wing base; two smaller setae on each scutellum. Pleural surfaces, coxae and mera light brown, darkest on anterior mesepisternum, with scattered pale hairs most numerous on anterior surfaces of fore and middle coxae; three large, dark setae vertically aligned on posterolateral surface of hind coxa. Femora and tibiae dark yellowish brown with narrowly blackened tips; tarsi brown; hind femora of male slightly thickened near mid-length.

Wings tinged with grayish brown, stigma only slightly darker than membrane generally; indistinct darker clouding along most cross-veins, at origin of radial sector (ORs), at nearly perpendicular origin of  $R_{2+3}$  from  $R_s$ , at origin of media (OM), along diagonal line of cross-veins from fork of  $R_{4+5}$  to end of  $Cu_2$ , and at end of  $R_5$  at somewhat pointed apex of wing. Scv beyond ORs; two pterostigmal cross-veins; no apical cross-vein between  $Cu_2$  and 1A. Six conspicuous black setae along posterior margin of fore wing between wing base and end of vein 2A; fewer (usually 4) along similar margin of hind wing. Outermost radial and medial cells narrowed near apex of wing. Pale thyridium at first fork of M.

*Abdomen of male:* Terga 2-7 unevenly light brown to brown with short, pale hairs; tergum 8 slightly darker brown than preceding terga or epiandrial appendages; sterna 2-6 narrow, slightly paler than corresponding terga. Sternum 7 only weakly sclerotized (Fig. 69); sternum 8 membranous ventrally, with small, subtriangular sclerite at each side; sternum 9 normally developed at sides but completely divided ventrally by membrane. Epiandrial appendages extending well beyond basistyles, in lateral aspect abruptly narrowed shortly before mid-length, then tapering toward apex, apical one-third curved mesad; long, slender dark brown to black setae along dorsal and ventral margins, ventral ones inclined mesad; 3-5 short, thick black setae at apex. Diagonal shelf or ridge on mesal surface of each epiandrial appendage, beginning near anterior dorsal margin and widening backward toward

abruptly transverse posterior edge (Fig. 71); shelf smooth, without setae on dorsal surface, bare surface also extending along dorso-mesal part of appendage; about 15 short, recurved black spines (thick at base, with acuminate tip) on mesal edge of lower, posterior one-third of shelf; 3-4 similar spines on mesal surface of appendage below shelf. Basistyles dark brown, about twice as long as dorso-ventral width; long setae at posterior end, fewer along dorsal edge. Dististyles short, inwardly curved, bluntly rounded at tips. Cerci about as long as epiandrial appendages, with numerous recurved, blackish brown setae on dorsal and mesal surfaces from about mid-length to apex. Upper branch of proctiger arched at tip, with long, black apical setae directed ventrad; lower branch slender, filiform near tip. Aedeagus slender near base, not coiled, filiform in approximately apical half.

*Abdomen of female:* Terga 2-8 unevenly light brown to brown with short, pale hairs; sterna slightly wider than in male, paler than corresponding terga; pleura light grayish brown. (Two teneral females not used in color description.) Tergum 8 (Fig. 70) notched at each side; eighth abdominal spiracle in this notch. Sternum 8 completely divided ventrally, sides bluntly pointed anteriorly, widely separated by membrane, separation narrowing posteriorly; broad connection between sternal plate and respective half of subgenital plate, with subcrescentic, membranous dorsolateral separation. Halves of subgenital plate narrowly separated ventrally (with membrane extending beyond posterior margin in specimen softened in de-



**Figs. 69-71.** *Bittacus disternum* n. sp. 69, terminal abdominal segments, male paratype, left lateral aspect. 70, terminal abdominal segments, female paratype, left lateral aspect. 71, left epiandrial appendage and proctiger, dorsal aspect. **Figs. 72-73.** *Bittacus sylvaticus* n. sp., male holotype. 72, terminal abdominal segments, left lateral aspect. 73, epiandrial appendages, dorsal aspect (most hairs omitted). Scale, all figures.



tergent); numerous stiff, black setae on and near posterior margin. Eggs cuboidal, with surfaces circularly impressed.

**Measurements:** Body length, male, about 19-20.5 mm (holotype 19 mm); female, about 10-19 mm (allotype 17 mm). Length of fore wing, male, 21.1-22.0 mm (holotype 21.6 mm); female, 19.6-21.0 mm (allotype 21.0 mm). Antennal length about 8.2-8.5 mm.

**Types:** Holotype, male, collected at Monteverde, elev. 1280 m, Puntarenas Province, Costa Rica, 26 May 1989, by J. S. Ashe, R. W. Brooks and R. A. Leschen (Snow Entomological Museum Costa Rica Expedition, no. 488), in SEM. Allotype female, 2 male and 2 female paratypes same data as holotype; same, except one male in flight intercept trap, 24 May 1989 (SEM). Additional paratypes, all from Costa Rica: Monteverde vicinity, 1400-1700 m, Erwin and Hevel Central America Expedition, 6-14 June 1973 (1 male; USNM); Cartago Prov., Turrialba, Centro Agronómico Tropical de Investigación y Enseñanza, 26-29 June 1986, G. E. Bohart and W. J. Hanson (1 female; Utah State University); Turrialba, Instituto Interamericano de Ciencias Agrícolas, at light, 9 p.m., 10 September 1964, R. B. Roberts (1 female, SEM); Turrialba, at light, 27 July and 8 August 1965, G. C. Eickwort (2 teneral females, SEM).

At the type locality, the bittacids were collected from herbaceous plants on a shaded, flat area near a small stream, and all (of collection no. 488) were found within a small area estimated to be 15 x 30 feet (4.5 x 6.1 m).

*Bittacus disternum* is the only known species in the genus that has the eighth and ninth sterna in the male completely divided by membrane; hence the name (Latin *di* = separate + sternum). Long cerci occur in males of some other Central American and Mexican species of *Bittacus*, but none of these has epiandrial appendages resembling those of *B. disternum*. The eighth tergum and sternum and the subgenital plates of the female of *B. disternum* are also of a shape not seen in any other species. The wings are unlike those of other bittacids in their peculiar pattern of clouding and the narrowing of radial and medial cells near the apex.

### *Bittacus sylvaticus* new species

Description based on two males, pinned.

**Head:** Dorsum and frons sordid yellowish brown, ocellar prominence dark brown to black; diameter of lateral ocelli 1.8-2.0 times that of median ocellus. Rostrum yellowish brown basally, amber-brown apically, dark reddish brown between; mouthparts amber-brown except maxillary palps brown. Antennal scape, pedicel and flagellum light brown; 21-22 flagellomeres, indistinct beyond 16 or 17, with hairs about as long as diameter of more basal flagellomeres, 5 times diameter on outer ones.

**Thorax:** Anterior propleura dark brown, roughly semicircular, their posterior edges beneath pronotum. Pronotum dark yellowish brown medially, unevenly darker brown at sides; one conspicuous black seta at each side on anterior margin, one on each side near posterior margin, the two setae in longitudinal alignment. Mesonotum unevenly light brown in slightly depressed median areas and on scutellum, darker brown on sides and anteriorly, with few very short hairs; one long, black seta near wing base, two smaller setae on scutellum; metanotum paler than mesonotum and without setae near wing bases. Mesothoracic pleura, coxae and mera unevenly grayish brown, darkest on episternum, palest on epimeron; scattered pale hairs longest and most dense on anterior surface of coxae; anepisternum slightly raised, with two black setae; metathoracic pleura, coxae and mera light brown. Femora dark yellowish brown to grayish brown, dark brown at apex; hind femora not expanded; tibiae yellowish brown, brown at apex, with yellow hairs and sparse black setae; tarsi yellowish brown with dark reddish brown claws.

Wings tinged with smoky brown, stigma and markings brown; apex of wing forming approximately a right angle at end of vein  $R_5$ . Diffuse spots at ORs, FRs, OM, surrounding pale thyridium at FM, in medial cells and in outer radial cells, especially outer cell  $R_4$  at wing tip; diagonal darkened band from first r cross-vein across r-m, first m, around small thyridium at origin of  $M_1$  and across m-cu. Diffuse spots enclosing both pterostigmal cross-veins, along  $r_2$ - $r_3$  cross-veins, at end of  $Cu_2$  and along posterior medial cross-veins.

**Abdomen of male:** Terga 2-5 unevenly dark yellowish brown to brown, with short yellowish setae; tergum 2 with 4-5 conspicuous black setae along each lateral margin and light brown spot narrowly bordered with dark brown on each side at anterior end; sterna 2-5 long and slender, drawn up beneath terga in dried specimens, 2-4 pale yellowish brown to tan, 5 somewhat darker. Tergum 6 only about 0.7 as long as 5, and 7 only 0.4 as long as 5; both darker than 2-5. Sterna 6-7 short, brown, with tan markings on 7; sterna 8-9 membranous medially, together shorter than sternum 7. Tergum 8 short, broadly emarginate dorsomedially. Epiandrial appendages (Figs. 72, 73) dark brown, about four times length of basistyles, apical half strongly downcurved with dorsal margins rotated laterad so mesal face becomes largely dorsal; hairs increasing in length toward apex; low, rounded, transverse ridge on mesal face of each appendage at level of rotation, with short, curved, black spines at highest point of ridge; about 15-20 longer black spines, curved cephalad, near dorsal margin (but at different levels so exact count difficult) between transverse ridge and widest separation of appendages. Basistyles short, their dorso-ventral width about equal to length; short brush of hairs on postero-ventral margin. Dististyles short, curved inward, flattened and slightly expanded at apex. Cerci nearly as long as epiandrial appendages, pale tan, with short hairs on ventral surface, abundant longer, recurved hairs on dorsal surface except near base. Upper branch of proctiger protruding between bases of epiandrial appendages, bifurcate at apex; lower branch slender, tapering. Aedeagus unmodified, not greatly expanded at base, filiform in approximately apical half, not coiled.

**Measurements:** Body length, male, about 20.0-21.0 mm (holotype 21 mm). Length of fore wing 21.9-23.0 mm (holotype 23.0 mm). Antennal length about 7.1 mm.

**Types:** Holotype, male, collected in cloud forest 4.8 miles (7.7 km) northeast of Coscomatepec, Veracruz, Mexico, elevation about 1420 m, on 8 August 1969, by G. W. Byers (field cat. Veracruz no. 17). Paratype, one male, same locality, collected 22-23 July 1966, by O. S. Flint, Jr., and M. Ortiz. The holotype is in the SEM, the paratype in the USNM.

The habitat at the type locality is described and its subsequent alteration discussed under *Panorpa involuta*, above. This new *Bittacus*, the new *Panorpa* and a new species of *Kalobittacus* (Byers, 1994) were all found during the first half-hour of collecting in this remarkable habitat. The name of the new *Bittacus* (Latin *sylvaticus* = of the forest) refers to the deeply shaded, cool and moist habitat in which the species was found, most Mexican bittacids being found in much lower, drier and warmer environments.

*Bittacus sylvaticus* somewhat resembles *B. banksi* Esben Petersen in the lateral aspect of the epiandrial appendages and length of cerci. In *banksi*, however, the epiandrial appendages are not twisted or rotated near mid-length. The many spots on the wings of *sylvaticus* give it an almost mottled appearance not seen in any other Mexican species, although there are Mexican species of *Bittacus* with dark (but uniformly smoky) wings. In wing maculation and generally dark coloration, *B. sylvaticus* resembles *B. maculosus* Byers of Trinidad; however, the male of that species, described later in this paper, has quite different structure of the ter-



minial abdominal segments. The membranous medial separation of sterna 8 and 9 resembles the condition in *B. disternum* although it is much less extensive.

### *Bittacus spatulatus* new species

Description based on 21 males and 32 females, pinned, and two males in alcohol. Additional specimens have been examined, but their condition is so poor that they are not included as paratypes.

**Head:** Dorsum and frons sordid dark yellowish brown; ocellar triangle black; diameter of lateral ocelli about 1.3 times that of median ocellus. Rostrum dark amber-brown, subgenae darker brown; mouthparts amber-brown, terminal segment of maxillary palps paler than other segments. Antennal scape and pedicel yellowish brown to amber-brown; flagellum blackish brown, with 21-22 flagellomeres, indistinct beyond 13.

**Thorax:** Pronotum sordid yellowish brown, with three transverse ridges, anterior one thickest and most elevated, with two large, black setae at each side, one dorsolateral, one lateral; posterior ridge with two shorter black setae at each side above anterior spiracle; posterior edge of pronotum curving around spiracle and converging with anterior edge so each side of pronotum terminates laterally in a sharply acute angle. Mesonotum unevenly dark yellowish brown except scutellum somewhat paler (much variation in shades of color apparently due to post-mortem changes); mesoscutum with conspicuously raised oblong area above and before each wing attachment; scutum with fine, pale, very short hairs, longer ones on scutellum slender, brown. Metanotum dark yellowish brown except scutellum slightly paler than scutum; hairs as on mesonotum. Pleural surfaces, coxae and mera unevenly brown with scattered yellow hairs, most dense on anterior surfaces of coxae, and fine, pale pubescence; two black setae vertically aligned on mesothoracic anepisternum, one or two on epimeron, two on metepimeron, 2 on fore coxa and 2-5 on hind coxa. Femora and tibiae yellowish brown, narrowly darkened with brown to blackish brown at apex, with black setae. Fore and middle tarsi yellowish brown, hind tarsus reddish brown; basitarsus of fore leg longer than tarsomeres 2-5 together, that of middle tarsus shorter than 2-5; hind basitarsus about one-third length of tarsomeres 2-5 together.

Wings slightly iridescent, strongly tinged with yellowish brown, without markings; stigma yellowish brown, veins dark yellowish brown to reddish brown; two stigmal cross-veins. Scv about mid-way between ORs and FRs; apical cross-vein present near end of 1A, before level of FRs. Five or six conspicuous black setae on both costal and hind margins of fore and hind wings between base and end of 2A. Inconspicuous pale thyridium at FM.

**Abdomen of male:** Terga 2-8 unevenly yellowish brown to sordid yellowish brown, with abundant short, yellow hairs; corresponding sterna slightly paler; sterna 3-6 long and narrow, usually drawn up beneath terga and largely concealed in dried specimens. Lateral margins of tergum 2 with usually 7-8 (range 7-12) conspicuous black setae on each side; tergum 3 with 7-14 shorter black setae on each side, fewer (1-6) on sides of terga 4 and 5. Tergum 8 broadly emarginate posterodorsally (Fig. 76). Epiandrial appendages (Figs. 74, 76) yellowish brown, much longer than basistyles, divergent (but not always as much as in Fig. 76), narrowest near mid-length and twisted so that mesal surfaces face dorsad or nearly so. Row of short, stout, recurved black spines along inner, dorsal edge of each epiandrial appendage, extending from near base to approximately mid-length, then turning diagonally ventrad to about mid-width of appendage. Small group of similar spines near ventral edge, near base of appendage. Apical half of each appendage expanded, somewhat concave and glabrous on upper (mesal) surface, with rounded posterior edge; glabrous, glossy surface bordered dorsally, ventrally and posteriorly by long, inwardly (or dorsally) directed setae; other long setae nearly perpendicular to margins. Basistyles only about half as long as epiandrial appendages, yellowish brown with yellow hairs; dististyles short, inwardly curved, narrowed subapically, apex strongly sclerotized.

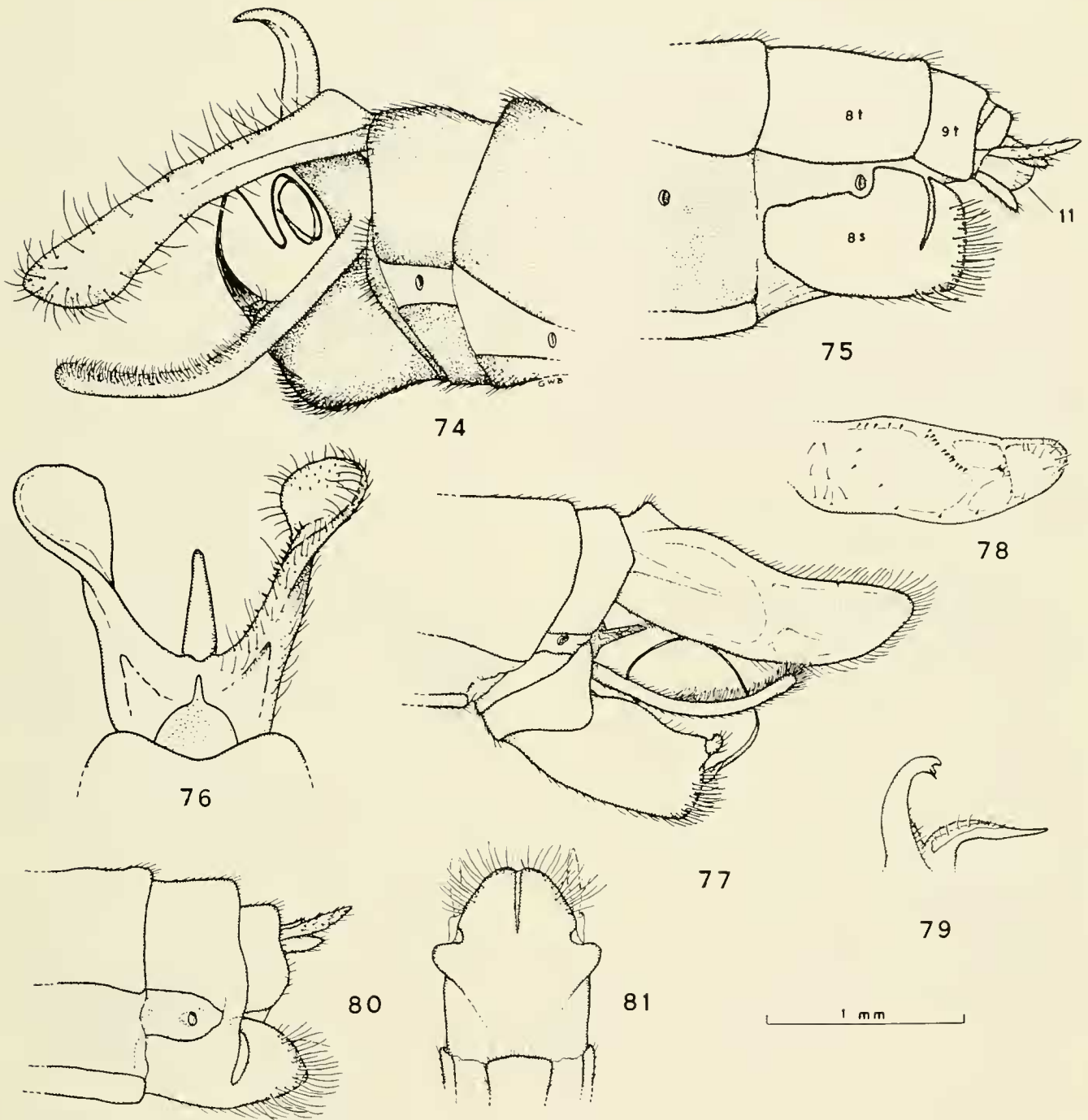
Cerci long, extending nearly to ends of epiandrial appendages, with dense yellow hairs, those along entire dorsal surface suberect, slightly recurved. Aedeagus subconical near base, filamentous for most of its length (first coil often adhered to lower branch of proctiger, in dried specimens, and subsequent coils adhered to walls or floor of genital chamber). Upper branch of proctiger glabrous, arched upward between bases of epiandrial appendages; lower branch long-triangular with few bordering setae.

**Abdomen of female:** Sordid yellowish brown to dark brown with abundant short, yellow hairs; specimens containing numerous eggs darker than those that had laid most eggs. Sternum 8 and subgenital plate broadly joined (Fig. 75) but partially separated by deep, narrow notch in dorsal margin; membranous ventral separation wide anteriorly between sclerites of sternum 8, converging to narrow separation of subgenital plates. Sternum 8 curved around spiracle posteriorly; subgenital plate truncate posteriorly, with long setae, some slightly upturned. Segments 10 and 11 withdrawn under tergum 9, cerci partially visible, in dried specimens (cf. Fig. 75). Eggs cuboidal with surfaces impressed.

**Measurements:** Body length, male, about 20.7-23.2 mm (holotype 23.1 mm); female, about 18.0-20.4 mm (allotype 20.4 mm). Length of fore wing, male, 20.3-24.2 mm (holotype 24.0 mm); female, 20.6-23.5 mm (allotype 22.1 mm). Antennal length, male, about 9.2-10.8 mm (holotype 10.0 mm); female 9.1-10.3 mm (allotype 10.3 mm).

**Types:** Holotype, male, allotype female, 3 male and 6 female paratypes collected near Taboga (14 miles SW of Cañas), Guanacaste Prov., Costa Rica, 25-26 July 1967, by Oliver S. Flint, Jr. Additional paratypes: COSTA RICA: Guanacaste, Bagaces, Río Piedras, 27 July 1967 (1 male, 3 females); Guanacaste, 1.5 mi. S of Potrerillos, 27 July 1967 (1 female); Guanacaste, Las Cañas vicinity, Río Corobici, 26 July 1967 (3 males); all these localities are on the Interamerican Highway, all specimens collected by O. S. Flint, Jr. (USNM, SEM). Guanacaste, 14 km south of Cañas, at flight-intercept trap, 3-9 July 1988 (1 male), 1-4 Sept. 1989 (1 female), 15-22 Jan. 1990 (1 male), 29 July 1990 (1 female), 1-12 Aug. 1990 (1 male, 1 female), 14-17 Aug. 1990 (1 male), 16-19 Sept. 1990 (1 male), 1-22 June 1991 (2 males, 2 females), 22-30 June 1991 (1 male, 2 females), 1-10 July 1991 (1 male, 1 female), all collected by Frank D. Parker (USU, SEM). Guanacaste, Palo Verde, 5 July 1976, Robert Gorton (1 male; USNM); S. Cañas Exp. Sta., 1-8 August 1988, F. D. Parker (2 males, 1 female; USU). Puntarenas, Playa Naranjo, 19 July 1975, L. F. Jiron (1 male). NICARAGUA: Chontales, 4 miles NW of Acoyapa, 29 July 1967, O. S. Flint, Jr. (1 female; USNM); Masaya, Las Flores, June 1987, at uv. light, J.-M. Maes (1 male); Leon vicinity, Lake Telica, July 1990, B. Garcete (2 males); Masaya, Las Flores, in Malaise trap, 1 July 1994 (1 male), 8 July 1994 (1 male, 4 females), 27 July 1994 (2 females), all collected by Jean-Michael Maes (MELN). Holotype, allotype and paratypes as indicated in the USNM; paratypes in SEM and other collections as indicated.

*Bittacus spatulatus* closely resembles *B. banksi* Esben-Petersen in size and in venation and coloration of wings, and its known range falls completely within that of *banksi* (Mexico to Panama). Differentiation of females of these two species is particularly difficult. Males of *B. spatulatus* can be recognized by the peculiar rotation and subapical widening of the epiandrial appendages. It is this characteristic combined with the shallowly concave, upturned mesal surface that gives the species its name (Latin *spatula* = diminutive form for a broad, flat spoon or stirring tool). The distal one-third of an epiandrial appendage in *B. banksi*, while somewhat widened, is not particularly concave on the mesal surface, and the epiandrial appendages are ordinarily held close together (subparallel), not divergent as in *spatulatus*. In males of *B. spatulatus* from near Cañas, Guanacaste, Costa



**Figs. 74-76.** *Bittacus spatulatus* n. sp. 74, terminal abdominal segments, male paratype, right lateral aspect. 75, terminal abdominal segments, female paratype, left lateral aspect; s - sternum, t - tergum, eleventh segment indicated. 76, epiandrial appendages and proctiger, dorsal aspect. **Figs. 77-81.** *Bittacus peninsularis* n. sp. 77, terminal abdominal segments, male holotype, left lateral aspect. 78, mesal aspect of right epiandrial appendage to show distribution of spines, hairs and ridges. 79, proctiger of male, left lateral aspect. 80, terminal abdominal segments, female paratype, left lateral aspect. 81, same, ventral aspect, showing undivided eighth sternum. Scale, all figures.



Rica, the ratio of greatest width of the apical one-third to the narrowest near mid-length of an epiandrial appendage, seen in lateral profile, is 1.87-2.0 to 1, while in *B. banksi* from the same locality it is only 1.17 to 1. Less conspicuous rotation of the epiandrial appendages is seen in *B. sylvaticus*, a Mexican species that can be recognized by its darkly marked wings and quite differently shaped epiandrial appendages (compare Figs. 76 and 73). Females of *B. spatulatus* have the posterior edge of the subgenital plate (on each side) nearly vertical, or truncate; however, in dried specimens there is often enough deformity to make this difficult to see.

### *Bittacus peninsularis* new species

Description based on 27 males, 23 females, pinned; 18 additional females seen but not made paratypes because of poor condition.

**Head:** Dorsum unevenly brown to dark brown; ocellar prominence black; ocelli strongly protruding; lateral ocelli longer than high, greatest length 1.45-1.75 times that of median ocellus; frons deeply recessed below median ocellus and between antennal bases. Rostrum dark amber brown near base darkening toward apex; prominent subgenal ridge at each side of clypeus below eye; mouthparts amber-brown, maxillary palps black. Antennal scape and pedicel sordid brown, flagellum black, with 21-23 flagellomeres (indistinct beyond 14), hairs on flagellomeres beyond third longer than diameter of flagellomere, increasingly so distally.

**Thorax:** Pronotum sordid yellowish brown; 4-6 conspicuous black setae on anterior margin, one dorsolateral, one or two more lateral, on each side, each on slight elevation; two setae on posterior margin; anterior spiracle appressed to posterior margin on each side. Mesonotum and metanotum unevenly dark yellowish brown with numerous short, yellowish hairs; conspicuous black seta at each side on mesonotal prominence above and before wing attachment; two smaller black setae on mesonotal scutellum. Pleural surfaces, coxae and mera unevenly brown with fine whitish pubescence and scattered yellow hairs, latter most dense on coxae; 1-2 large black setae on mesothoracic anepisternum, 1-2 on meso- and metathoracic anepimera, 2-4 in vertical alignment on hind coxa. Femora and tibiae dark yellowish brown to amber-colored, narrowly darkened at apex; four uneven rows of long, black setae along dorsum and sides of hind femur. Tarsi only slightly darker than legs; fore and middle basitarsi subequal in length to tarsomeres 2-5 together; hind tarsi thicker than others, basitarsus about two-thirds as long as fore basitarsus.

Wings strongly tinged throughout with dark yellowish brown, slightly darker around apical margin, somewhat iridescent; stigma scarcely darker than adjacent wing membrane; veins brown to amber-brown; two pterostigmal cross-veins. On posterior margin of fore wing and on both costal and hind margins of hind wing, 4-5 conspicuous black setae between wing base and level of end of vein 2A. Sc joins C beyond FRs; Scv about half-way between ORs and FRs; no apical cross-vein between Cu2 and 1A. Pale (not whitish) thyridium at FM.

**Abdomen of male:** Terga yellowish brown (terga 2-5 of holotype) to sordid dark yellowish brown, with abundant short, yellowish hairs; sterna slightly paler, those of segments 2-6 usually drawn upward and concealed by terga in dried specimens; 7-9 black setae along each side of combined terga 1-2, 7 on each side of tergum 3, 4 on tergum 4, 0-2 on tergum 5. Epiandrial appendages (Fig. 77) unevenly yellowish brown, slightly darker near apex, extending well beyond ends of basistyles, with thickened margins and pale ridge at mid-width from base to one-fourth to half length of appendage. Three or four short black spines along inner, dorsal edge of appendage (Fig. 78), about 12 on diagonal ridge on mesal surface between dorsal margin and mid-width, ridge increasing in height (thickness) toward lower, caudal end; two larger black setae on

small prominence farther caudad; scattered hairs on inner surface of appendage near apex and hairs and spines elsewhere, as illustrated. Basistyles about twice as long as high, with long setae on posterior surface; dististyles small, simple, incurved to rounded apex. Aedeagus only slightly enlarged near base, mostly finely filiform, with more than three full coils (usually adhered to wall of genital chamber and not seen in dried individuals). Cerci longer than basistyles, shorter than epiandrial appendages, with long, slightly recurved hairs on dorsal surface of distal half and dense tuft of long hairs at apex. Dorsal branch of proctiger (Fig. 79) arched upward and backward to bifurcate tip, largely glabrous except along ventrolateral margins; lower branch tapering to acute apex, with few long setae along each side.

**Abdomen of female:** Terga and sterna unevenly yellowish brown, as in male. Eighth tergum and sternum joined by lightly to moderately sclerotized (not membranous) band behind spiracle (Fig. 80); area of fusion protruding to side in ventral aspect (Fig. 81); sternum 8 not divided ventrally, with median band of short, yellow hairs; subgenital plates separated by narrow, mid-ventral membranous zone. Subgenital plates rounded posteriorly, with long setae; anterodorsal tip of each inserted beneath sclerotized bridge between eighth tergum and sternum.

**Measurements:** Body length, male, about 15.5-17.5 mm (holotype 17.2 mm); female, about 13.8-16.6 mm (allotype 15.6 mm). Length of fore wing, male, 18.2-20.0 mm (holotype 20.0 mm); female, 17.0-19.8 mm (allotype 19.0 mm). Antennal length, male, about 9.5 mm, female about 8.2 mm.

**Types:** Holotype, male, allotype and 5 male, 9 female paratypes collected at black (ultraviolet) light, at Ramal de Naranjas, 6 miles west of Highway 1 near Santa Anita, Baja California Sur, Mexico, on 11 October 1983, by F. G. Andrews and D. K. Faulkner. Holotype, allotype and most paratypes in SDM; 3 male, 1 female paratypes in SEM. Additional paratypes, all from Baja California Sur: El Salto, 8 miles northeast of Todos Santos, at black light, 9 Oct. 1983, Andrews and Faulkner (5 males, 7 females; SDM, SEM); 36.6 miles southeast of Todos Santos, 10 Oct. 1983, Faulkner and Andrews (3 males, 2 females; SDM); Sierra de la Laguna, road to San Antonio de la Sierra, 8.5 road miles S and E of Highway 1 (KP#148), 2400 ft., 8 Sept. 1984 (no. 88,433), J. P. and K. E. Donahue (1 male, 1 female; LACM); same general locality but 1.7 road miles from Hwy. 1, 1500 ft., 12 Sept. 1984 (no. 88,574) (1 male, 1 female; LACM); Rancho la Burrera, 1800 ft., 6 Oct. 1975, R. R. Snelling (8 males, 1 female; LACM, SEM); 3 miles southwest of San Antonio, 14 Oct. 1972, E. M. and J. L. Fisher (1 male; SEM); Cañon de la Zorra, 6 miles west of Santiago, 1000 ft., 16 Oct. 1972, D. C. Marqua (1 male, 1 female; SEM).

*Bittacus peninsularis* resembles *B. texanus* Banks in numerous details of color and structure and will be identified as that species in existing keys. Seeing specimens of both species side by side, one notices the smaller size of *B. peninsularis* (its largest individuals approximately the size of the smaller ones of *B. texanus*) and its somewhat paler wings. The ranges of these two species are separated by over 1500 km (about 940 miles), but the ranges of both are only poorly known. Males of *peninsularis* can rather readily be differentiated from those of *texanus* by the epiandrial appendages, which are shorter and wider in *peninsularis*; this can be stated as a ratio of total length of the appendage to its width at mid-length, which is 3.35 in *peninsularis* and 4.40 in *texanus*. The diagonal ridge on the inner surface of the epiandrial appendage in *peninsularis* is not present in *texanus* but is probably represented by a prominence near the dorsal edge bearing a few black spines; and in *texanus* there are several more spines (number varies) along the inner dorsal margin of the appendage between its base and mid-length. Females of *texanus* have, on each side of tergum 8,



a prolongation downward behind the spiracle, into the notch between sternum 8 and the subgenital plate, but the connection of tergum and sternum is not complete as it is in *peninsularis*.

In a letter, Dr. Faulkner described the habitats at the sites of his collections as having lush thorn scrub vegetation with occasional oaks and palms, the ground dry, however, as there had been no rain for several days. Bittacids taken at light on 9 October were catching and feeding on small Lepidoptera; one paratype is pinned together with its prey, a small moth.

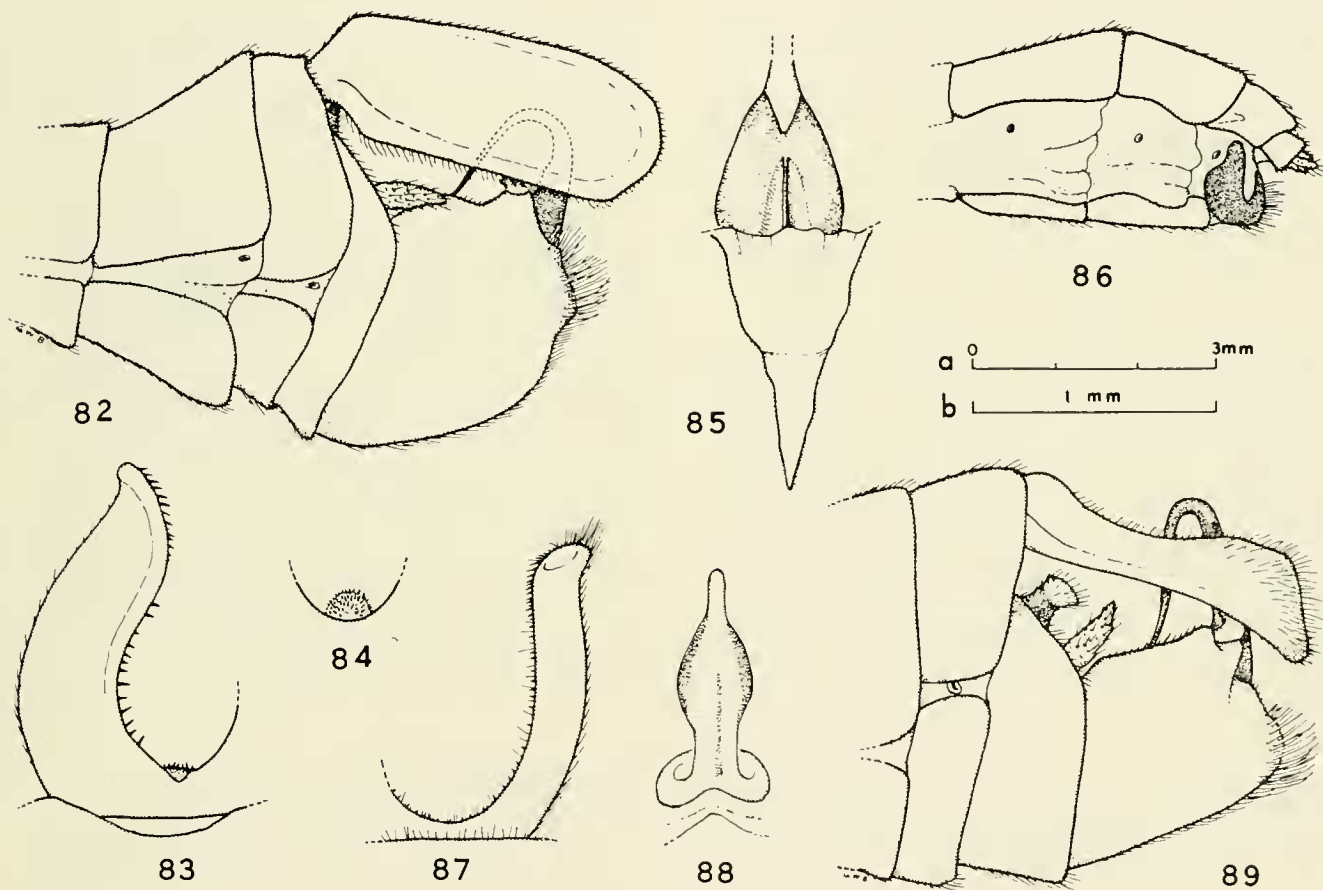
The species takes its name from its occurrence at the southern end of the peninsula of Baja California.

*Bittacus pignatellii* Navás

Although this is a large bittacid, of striking appearance because of its size, its black-tipped femora and tibiae and

its maculate wings, and although it lives in an area where there has been extensive insect collecting, a second specimen was not found until 50 years after publication of the original description (Navás, 1932). The female holotype was collected at Punta de Sabana, Darién, in eastern Panama. The second female was found near Santa Clara, Chiriquí, at an elevation of 1200 m, in western Panama, 22-25 May 1982, by Brett C. Ratcliffe, who donated it to the Snow Entomological Museum. More recently, the first known male of this species was collected at a mercury vapor light operated at Quebrada Juan Grande, km 2 on Pipeline Road, former Panama Canal Zone, on 9 June 1993, by Steven W. Lingafelter of the Snow Museum.

Navás' description of *Bittacus pignatellii* dealt largely with color. Some structural characteristics of the holotype deserve mention, including: Diameter of lateral ocelli twice that of median ocellus. Antennae with approximately 19 flagellomeres (not distinct beyond 15th). Pronotum with



**Figs. 82-86.** *Bittacus pignatellii* Navás. 82, terminal abdominal segments of male, left lateral aspect. 83, right epiandrial appendage (and part of left one) with spinose lobe at base partially visible. 84, spinose median lobe at base of epiandrial appendages, posterodorsal aspect. 85, base of aedeagus and membranous median separation of basistyles, posterior aspect. 86, terminal abdominal segments (6-11) of female holotype, left lateral aspect. **Figs. 87-89.** *Bittacus maculosus* Byers. 87, left epiandrial appendage of male, dorsal aspect. 88, base of aedeagus, posterior aspect. 89, terminal abdominal segments of male, left lateral aspect. Scale a, fig. 86; scale b, figs. 82-84, 87-89.

two large black setae on anterior margin and two on posterior margin. Thoracic pleura with silvery pubescence. Eighth abdominal sternum (Fig. 86) darkly sclerotized, with lateral extension behind spiracle at each side and with broad attachment to nearly vertically-oriented, setose subgenital plate; halves of subgenital plate very narrowly separated along ventral midline.

All the wings of the holotype are somewhat tattered, but I was able to make a restoration of the right fore wing (Fig. 90) by reference to the others. The wings are tinged with yellowish brown, the markings dark brown, the stigma particularly dark and elongate. Vein  $R_{2+3}$  turns abruptly from  $R_{4+5}$ ; and there is a conspicuous thyridium at the first fork of the media. I am grateful to Dr. P. Passerin d'Entreves, curator of insects in the Museo ed Instituto di Zoologia Sistemica, Università di Torino, Italy, for the loan of the holotype specimen.

The terminal abdominal segments of the male (Figs. 82-84) are characterized by thick basistyles deeply separated posteroventrally by a triangular membranous area (Fig. 85), and by outwardly convex epiandrial lobes sparsely covered with short hairs (Fig. 83) and bearing black spines on the dorsomesal margin. At the anterior separation of the epiandrial lobes, scarcely visible in dorsal aspect, is a low, rounded lobe bearing numerous black spines (Figs. 83, 84). The base of the aedeagus, in ventral aspect (Fig. 85), is glossy and dark brown with two subtriangular impressed areas separated by a median carina.

### *Bittacus maculosus* Byers

The original description (Byers, 1965) was based on one female, collected at light at St. Augustine, Trinidad (type in the USNM), and a second female was taken in Manaus, Brasil (Penny and Arias, 1982). Only recently the first male has been found. This male was collected at an ultraviolet light in wet forest just above St. Augustine, Trinidad ( $10^{\circ}39'N$ ,  $61^{\circ}24'W$ ), near Mount St. Benedict Stream, 250 m elevation, 20-25 June 1993, by Nancy E. Adams. I am indebted to Dr. Oliver S. Flint, Jr., of the National Museum of Natural History for sending me this specimen for examination.

In color characteristics, the male is much the same as the female holotype, allowance being made for slight post-

mortem changes in the color of thorax and abdomen in particular, in the two specimens. The second flagellomere of the male is apically darkened, like those beyond it, while the first two are pale in the female. Also there are some small differences in wing maculation.

The terminal abdominal segments of the male are distinctive: Epiandrial appendages slender, in lateral aspect somewhat narrowed near mid-length, then expanded apically, with a shallow apical depression (Figs. 87, 89). Numerous short, black spines along inner, dorsal margin of each lobe, those toward apex longer and more dense than those nearer base. Aedeagus thick near its base in lateral aspect (Fig. 89), relatively short and not coiled; in posterior aspect (Fig. 88) widened laterally beyond base, sides very darkly sclerotized. Dististyle hairy on outer curvature, with sharp, densely sclerotized, subapical point on inner surface. Proctiger short, of simple structure; cerci short, thick.

### *Kalobittacus maniculatus* new species

Description based on two males, four females, pinned.

*Head:* Dorsum dark yellowish brown except piceous around ocelli and brown band extending from eye to eye, arching above antennal sockets and including ocellar prominence. Frons below antennal bases and rostrum yellowish brown; subgenae slightly darker, maxillae dark amber-brown, maxillary palps yellowish brown. Antennal scape and pedicel light yellowish brown, flagellum gradually darkening toward tip; about 21 flagellomeres (indistinct beyond 14th); flagellar hairs longer than diameter of flagellomeres.

*Thorax:* Anterior propleura large, their posterior edges inserted beneath pronotum; setae yellow. Pronotum yellowish brown; anterior margin a rounded, transverse ridge somewhat expanded at sides; one or two black setae on each posterolateral corner above spiracle. Mesonotum, metanotum, pleural surfaces, coxae and mera unevenly yellowish brown. Pleura and coxae with scattered yellowish hairs, most numerous and longest on coxae; posterodorsal edges of mesothoracic and metathoracic mera narrowly black. Femora and tibiae yellowish brown to amber-brown, with black setae in poorly defined rows; hind femora of males slightly incrassate near mid-length. Fore and middle tarsi yellowish brown, with basitarsus as long as tarsomeres 2-5 together; hind tarsi darker brown, thicker, with shorter basitarsus.

*Wings* (Fig. 99c) faintly tinged with yellowish brown, hyaline, highly iridescent; stigma and apical spot dark brown. Stigma extending from costa to  $R_{2+3}$ ; two stigmal cross-veins. In fore wing, subcostal cross-vein near level of FRs, 1A ending at posterior margin at level of OM, vein 2A about half as long as 1A; cross-vein from 1A to posterior margin at or slightly beyond end of 2A. In hind wing, 1A fused with  $Cu_2$  to level of OM, turning as diagonal cross-

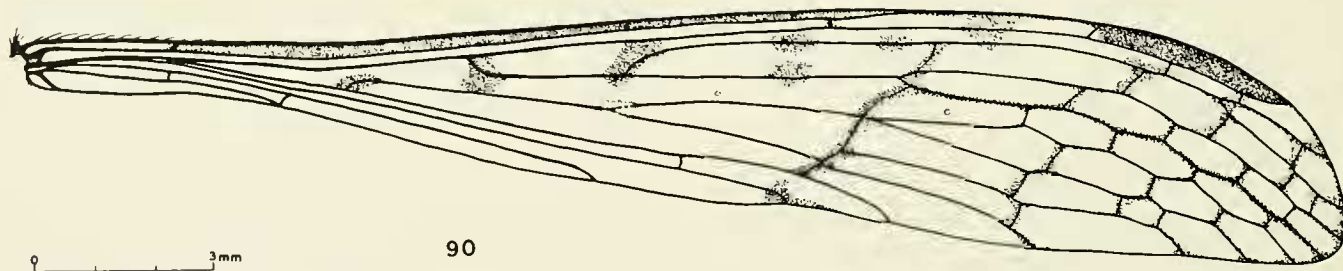


Fig. 90. *Bittacus pignatellii* Navás, right fore wing (composite drawing from all wings of female holotype).



vein to wing margin; 2A ending at level of humeral cross-vein, near wing base. Pale thyridium at first fork of M; nymata between  $R_{4+5}$  and  $M_{1+2}$  and between  $R_5$  and  $M_1$  where veins are closest together. Four black setae along costa of fore wing between base and level of end of 1A; two similar but longer setae on anal lobe of wing; four or five long, black setae on proximal costa of hind wing, similar number on posterior edge near wing base.

*Abdomen of male:* Terga 2-5 yellowish brown, with 4 conspicuous black setae on each lateral margin of tergum 2, 1 or 2 on sides of terga 3-5; corresponding sterna yellowish brown, narrow, deeply recessed beneath terga in dried specimens. Terga 6-8 conspicuously darker, blackish brown; tergum 6 about 0.6 as long as tergum 5, its posterior end 1.6 times as wide as anterior end; tergum 7 about 0.7 times length of 6, widening to 1.25 times its anterior width; tergum 8 short, wide, with broadly U-shaped posteromedian emargination. Epiandrial appendages (Figs. 91, 92) unevenly yellowish brown, gradually downcurved, about 1.7 times length of basistyles, with conspicuous thumb-like lobe on dorsal margin directed dorsad and mesad and bearing small group of short, black spines at apex, 0-3 others before apex on underside. Most setae on outer surfaces of epiandrial lobes slender and yellow; thicker, longer, black setae at apex and a few along subapical, ventral margin. Spine-tipped subconical lobe on inner surface of each epiandrial lobe near base; smaller lobe with only one terminal spine near lower mesal margin at level of "thumb." Sterna 8 and 9 and basistyles blackish brown except basistyles dark brown apically. Dististyles short, simple, curved inward. Aedeagus thick at base, with lateral expansions (pennunci), then elongate but not coiled, ending near proctiger. Proctiger branched, upper branch reaching dorsal margins of epiandrial lobes at their divergence; lower branch short. Cerci yellowish, acutely tipped, not reaching ends of basistyles.

*Abdomen of female:* Terga 2-4 yellowish brown, 5 slightly darker, 6-7 dark yellowish brown dorsally, blackish brown at sides; sterna 2-5 narrow, yellowish brown, 6-7 widening backward, dark brown. Tergum and sternum of segment 8 fused, pleura sclerotized (Fig. 93), glossy dark brown dorsally and ventrally, black at sides (and across anterior dorsum in one female) except pale around protruding spiracle; fused sclerites forming nearly complete ring, ventral edges narrowly separated by membrane. Anterior margin of segment 8 thickened on each side and protruding laterally as two rounded prominences. Subgenital plates dark yellowish brown with long apical hairs; narrowly separated ventrally by membrane.

*Measurements:* Body length, male, about 16.0-16.3 mm (holotype 16.3 mm); female, about 14.9-15.5 mm (allotype 14.9 mm). Length of fore wing, male, 17.0-17.8 mm (holotype 17.0 mm); female, 17.4-17.8 mm (allotype 17.4 mm). Antennal length, male and female, about 4.5-5.0 mm.

*Types:* Holotype, male, allotype, female, 1 male and 3 female paratypes collected 20 miles (32 km) northwest of Huehuetenango, Guatemala, 9-10 August 1967, by O. S. Flint, Jr. Holotype, allotype and 3 female paratypes in the USNM, male paratype in the SEM.

A few characteristics of *K. maniculatus* set this species quite apart from all known congeners. For example, the thumb-like process on the epiandrial lobe of the male and the fusion of the eighth tergum and sternum with lateral projections in the female are without equivalents in any other known species of *Kalobittacus*. In body color and wing maculation, *maniculatus* resembles *K. hubbelli* Byers of Honduras and *K. masoni* Byers of southern Mexico. The long epiandrial lobes somewhat resemble those of *hubbelli* and *masoni* but are curved downward instead of upward and are not narrowly rounded apically as in those species.

The name *maniculatus* refers to the "thumb" and general shape of the epiandrial lobes (Latin *maniculatus* = with or having little hands).

### *Kalobittacus inornatus* new species

Description based on one male preserved in alcohol; described patterns of color are probably reliable, while colors may vary from those of dried specimens or the living insects.

*Head:* Occiput and vertex behind ocelli light brown; anterior vertex brown from eye to eye; ocelli narrowly bordered with black; lateral ocelli approximately same diameter as median ocellus. Frons below antennal sockets brown; clypeus light brown, remainder of rostrum and mouthparts, including maxillary palps, yellowish brown. Antennal scape and pedicel light gray; flagellum pale yellowish brown with about 20 flagellomeres (long, with indistinct ends beyond eighth except terminal flagellomere short); hairs longer than diameter of flagellomeres in distal half of antennae.

*Thorax:* Pronotum brown, its anterior margin thickened and rounded as transverse ridge, without setae; posterior pronotum separated from anterior margin by deep transverse sulcus. Anterior spiracles large, their length greater than width of adjacent part of pronotum. Mesonotum brown anteriorly, slightly darker brown posteriorly, with intervening depressed area pale brown; scutellum pale gray (nearly white); few pale hairs on posteriormost scutum, two longer pale setae on scutellum. Metanotum similar to mesonotum except pale transverse area diffuse and indistinct. Propleura brown, inserted posteriorly beneath pronotum, but pleural suture visible; front of anterior coxae light brown, posterior half pale gray. Mesepisternum light brown, with one black seta and small group of short hairs on anepisternum below attachment of fore wing; mesepimeron and respective meron and coxa pale gray; metepisternum and coxa only, slightly darker than pale gray metepimeron and meron, anepisternum with few pale hairs. Femora pale near base, mostly dark yellowish brown, apex narrowly black; hind femora nearly twice diameter of middle femora throughout but not incrassate in appearance; tibiae dark yellowish brown, narrowly black at apex; anterior and middle tarsi yellowish brown, their basitarsi as long as tarsomeres 2-5 together; hind tarsi thicker, darker, with basitarsi only about half as long as those of other tarsi.

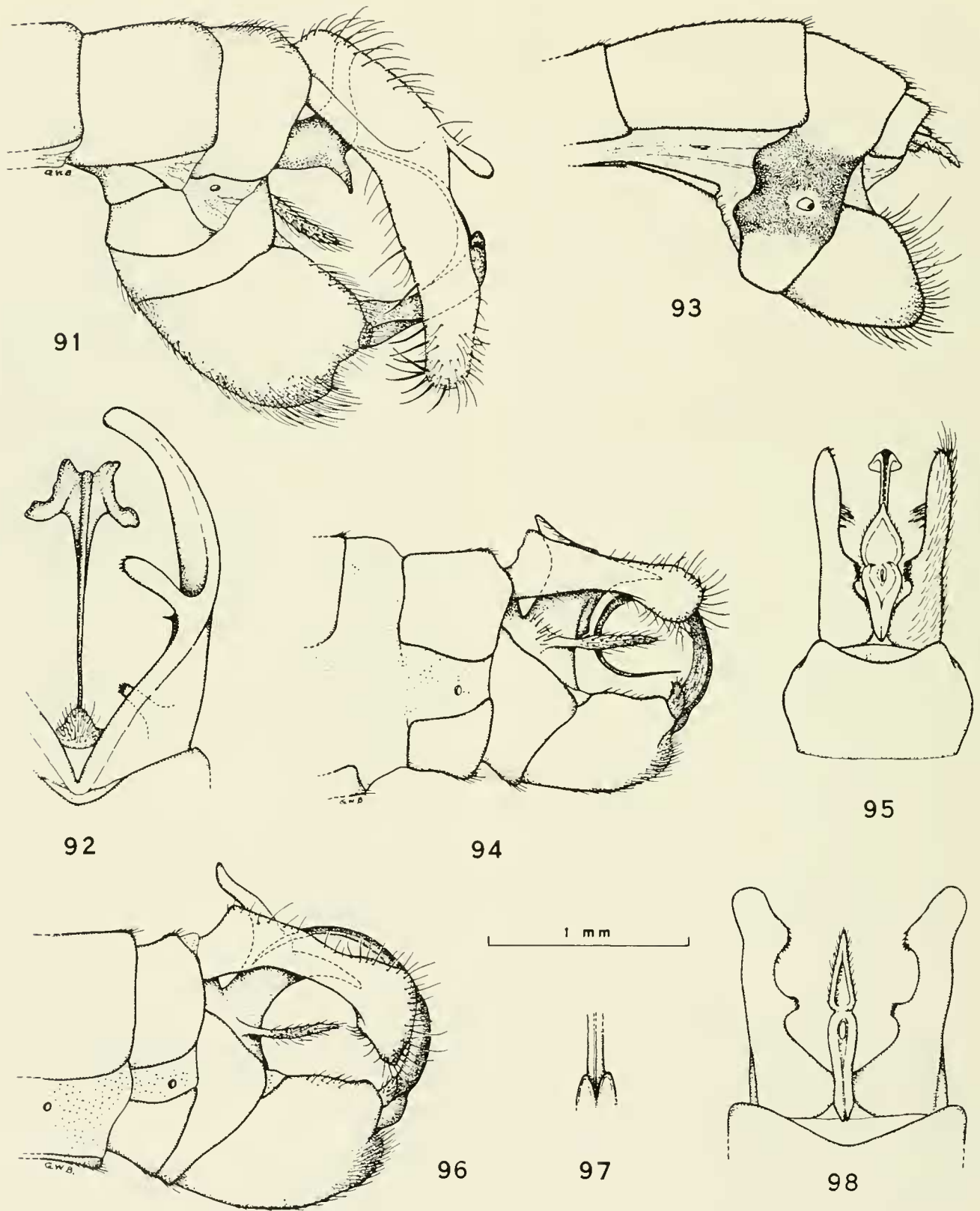
Wings hyaline, highly iridescent, faintly tinged with yellowish brown; stigma light yellowish brown, enclosing two pterostigmal cross-veins; faint, diffuse yellowish brown clouding at ORs, FRs and OM. No apical spot. Vein 1A joining hind margin of wing slightly beyond level of OM in fore wing, fused with  $Cu_2$  for most of its length in hind wing and crossing to margin as long-diagonal cross-vein.

*Abdomen of male:* Terga 2-6 light brown, 7 brown anteriorly except for narrow, black anterior edge, grading into yellowish brown posteriorly; tergum 8 brown with narrow, black anterior edge; sterna paler than corresponding terga. Caudal edge of tergum 8 broadly and shallowly emarginate. Epiandrial lobes (Figs. 94, 95) basally grayish brown with mixed pale and dark hairs, pale yellowish brown with mostly yellowish hairs in distal one-third; two or three black spines on inner caudal edge; tuft of hairs and single black spine on mesal surface slightly behind mid-length; low prominence nearer base with numerous small, black apical spines; sternum 9 pale laterally, brown ventrally. Basistyles brown; dististyles brown, simple, strongly curved inward, with abundant dark hairs. Aedeagus widened near base, its slender, brown median tube with pale brownish gray supporting structures along each side and tapering toward mid-length; apical half filiform, terminating near aedeagal base (i.e., nearly one full coil); brown swelling at each side near base. Cerci of medium length with acute apex and abundant setae. Proctiger pale gray near base, dorsal branch light yellowish brown, with yellowish hairs along sides; ventral branch pale with marginal hairs; separation of branches directed dorsad (Fig. 95).

*Measurements:* Body length, male, about 16 mm. Length of fore wing, male holotype, 17.8 mm. Length of antenna about 4.9 mm.

*Type:* Holotype, male, collected 6 km south of San Vito (southeasternmost Puntarenas Prov.), Costa Rica, 3 May 1967, by Donald F. Veirs; in the SEM.





**Figs. 91-93.** *Kalobittacus maniculatus* n. sp. 91, terminal abdominal segments, male holotype, left lateral aspect. 92, left epiandrial appendage and aedeagus, dorsal aspect. 93, terminal abdominal segments of female, left lateral aspect. **Figs. 94-95.** *Kalobittacus inornatus* n. sp., male holotype. 94, terminal abdominal segments, left lateral aspect. 95, epiandrial appendages, proctiger, aedeagus and eighth abdominal tergum, dorsal aspect. **Figs. 96-98.** *Kalobittacus demissus* n. sp., male holotype. 96, terminal abdominal segments, left lateral aspect. 97, base of aedeagus, posterior aspect. 98, epiandrial appendages and proctiger, dorsal aspect. Scale, figs. 91-96, 98.

The male of *Kalobittacus inornatus* has several similarities to males of *K. demissus*, such as the large proctiger with a virtually dorsal opening and the two branches turned in nearly opposite directions, the simple aedeagus without a complete coil, and the low, spinose projection on the dorsal edge of each epiandrial lobe. In being narrowed near mid-length and enlarged in the apical one-third, the epiandrial lobes of these two species show a general similarity, while these structures differ conspicuously in detail (compare Figs. 94, 96) and at the same time set *inornatus* and *demissus* apart from all other known species of *Kalobittacus*. It is the simple form of the epiandrial lobes, simple aedeagus and wings without conspicuous pterostigma or apical spot that suggest the name *inornatus* (Latin, simple, unadorned).

### *Kalobittacus demissus* new species

Description based on two males preserved in alcohol; described color patterns are probably reliable, but described colors may not be accurate for dried specimens or the live insects.

**Head:** Dorsum brown to blackish brown, black around ocelli; greatest width of lateral ocellus about 1.9 times diameter of median ocellus; frons dark brown, rostrum dark brown near base, unevenly amber-brown apically; mouthparts amber-brown, maxillary palps dark yellowish brown to brown. Antennal scape and pedicel sordid yellowish brown to brown, flagellum yellowish brown to light grayish brown, with 17-18 flagellomeres (indistinct beyond 11 or 12), apical one-third of terminal flagellomere black; hairs longer than diameter of outer flagellomeres.

**Thorax:** Anterior propleura conspicuous, oval, with pale marginal hairs; posterior edges inserted beneath pronotum. Pronotum brown, its anterior margin thickened and rounded, without setae; posterior margin thin, without setae. Mesonotum and metanotum light brown anteriorly and along median depression, slightly darker on elevated areas, with brown spot at each side just anterior to pale scutellum and diffuse brown spot near each wing base; no setae. Pleura, coxae and mera unevenly light grayish brown, with diffuse brown on anterior mesothoracic coxae and episterna; hairs fine, short and sparse. Femora brown, slightly darkened apically, with black setae; hind femora thickened near mid-length to nearly twice diameter of either end, with conspicuous black setae in mesal, dorsal and lateral rows of three each on thickened part. Tibiae light brown, darkened apically, with sparse black setae. Tarsi dark yellowish brown; basitarsi of fore and middle legs subequal in length to tarsomeres 2-5 together; hind tarsi enlarged, basitarsi relatively shorter.

Wings highly iridescent, hyaline, very lightly tinged with yellowish brown especially along anterior edges; veins and markings brown to dark brown. Stigmal spot large, dark brown, mainly between C and R<sub>2+3</sub>, enclosing two stigmal cross-veins. Apical spot brown, mostly in outermost cell R<sub>4</sub>, with extensions into parts of apical cells R<sub>3</sub> and R<sub>5</sub>; in fore wing, brown spots at ORs, FRs and OM mainly between R and M. Pale thyridium at FM, another, smaller one at base of M<sub>4</sub>. Four conspicuous black setae on costa of fore wing before level of OM; two or three similar setae on posterior edge near base; 2-4 black setae on each edge of hind wing, nearer base. In hind wing, 1A coalesced with Cu<sub>2</sub> for most of its length, crossing to hind margin near level of OM.

**Abdomen of male:** Terga 2-6 unevenly dark yellowish brown, 2-3 with sparse black setae on lateral margins; corresponding sterna long-rectangular, paler than terga. Terga 7-8 shorter than more anterior ones, dark brown to black; posterior edge of tergum 8 broadly emarginate; sterna 7-8 also short and darkened (color contrast between segments 2-6 and 7-8 greater in holotype than in paratype). Epiandrial appendages (Figs. 96, 98) blackish brown in approximately basal half, grading into dark yellowish brown near apex (holotype) or in apical one-third (paratype), their dorsal and

ventral edges nearly parallel in proximal 0.6, distal 0.4 widened, turned slightly outward but conspicuously downward, concave on inner or mesal surfaces, concavity surrounded by long yellowish hairs on dorsal, distal and ventral margins and by transverse ridge proximally; group of 6-11 short, black spines at upper end of ridge. On dorsal edge of each epiandrial lobe, near mid-length, a short, blunt, spinose projection directed mesad. Basistyles about as long as epiandrial lobes, dark brown with yellowish hairs; dististyles simple, small, inwardly curved. Aedeagus somewhat widened near base, with pair of rounded scales appressed to base posteriorly (Fig. 97), abruptly narrowed near mid-length, not coiled, terminating beside proctiger. Upper branch of proctiger curved cephalad between and above bases of epiandrial appendages; lower branch tapering, pale, with long setae. Cerci short, slender, acute at apex.

**Measurements:** Body length, male, about 15 to 17 mm (holotype 17 mm). Length of fore wing 16.5-18.0 mm (holotype 18.0 mm). Antennal length about 4.5 mm.

**Types:** Holotype, male, collected beside Interamerican Highway northwest of Esparta, northwestern Puntarenas Prov., Costa Rica, 8 August 1968, by Donald F. Veirs. One male paratype collected 4 miles (6.4 km) south of Rincón de Osa, Peninsula de Osa, southern Puntarenas Prov., Costa Rica, 3 May 1969, by Robin Andrews. Both specimens are in the SEM.

*Kalobittacus demissus* appears to be most closely related to *K. bimaculatus* Esben-Petersen and *K. similis* Byers, both of southern Mexico, on the basis of the structure of the epiandrial lobes, the aedeagus and the proctiger (cf. Byers, 1994: 1096, figs. 3-5). It most nearly resembles *bimaculatus* in wing markings. From both these species it differs most conspicuously in the apical portion of the epiandrial lobes; the posterior margin of these, in lateral profile, is concave in *bimaculatus* and *similis* but somewhat convex in *demissus*. While the dorsal edge of each lobe curves slightly upward to a posterodorsal point in the two Mexican species, it turns downward in *demissus* so that the widened apical part of the lobe appears to hang downward, hence the species' name (Latin *demissus* = hanging down, or drooping). The scale-like structures at the base of the aedeagus do not occur in *bimaculatus* or *similis*; and the proctiger in *demissus* is considerably larger than in those species, its branches separating more dorsally than in either *bimaculatus* or *similis*. And in *demissus* the apical wing spot is more restricted in extent than in *bimaculatus*.

No ecological data accompany either of the specimens of *demissus*.

### GEOGRAPHIC DISTRIBUTION

Following are locality records deemed significant additions to previously known ranges. State names in capital letters indicate new state records. Most of the specimens listed are in the Snow Entomological Museum, University of Kansas (SEM). Specimens in parentheses not seen, identified by Wes Bicha.

*Panorpa anamala* Carpenter. INDIANA, Elkhart Co., 26 July 1980 (1 male, 5 females); Jackson Co., 19 May 1979 (2 males, 2 females); Jennings Co., 27 June 1987 (2 males); Kosciusko Co., 26 July 1980 (1 male), 24 July 1981 (2 males, 1 female); Starke Co., 11 July 1979 (2 males), 8 Aug. 1979 (3 males, 1 female), 8 Aug. 1980 (1 male, 1 female); all collected by Wes Bicha and in his collection. The species has been recorded earlier from Illinois, Kansas and southward.



**Fig. 99.** Right fore wings of Mecoptera. a, *Panorpa involuta* n. sp., male paratype. b, *Panorpa bimaccula* n. sp., male paratype. c, *Kalobittacus maniculatus* n. sp., female paratype (small spur veins in first cell  $M_1$  are not typical).

*Panorpa bichai* Byers. INDIANA, Monroe Co., 9.6 km SE of Bloomington, 1 Sept. 1994, D. M. Windsor - 1 male (SEM); previously recorded only from Tennessee.

*Panorpa consuetudinis* Snodgrass. ALABAMA, Macon Co., 31 Aug. 1984, Wes Bicha (1 male, 4 females; WB); recorded earlier from as near as Mississippi.

*Panorpa dubitans* Carpenter. Wes Bicha adds the following counties in Indiana in which *dubitans* has been found by him: Jasper Co., 10 July-1 Aug.; St. Joseph Co., 24 July; White Co., 11-24 July. The type locality is Hessville, near Hammond, Lake Co., Indiana.

*Panorpa ensigera* Bicha. SOUTH CAROLINA, Marion Co., 10 Oct. 1993, Wes Bicha (4 males, 4 females; WB); Marlboro Co., 9 Oct. 1993, Wes Bicha (2 males, 4 females; WB). Species previously recorded from North Carolina.

*Panorpa hungerfordi* Byers. INDIANA, Brown Co., 24 August 1985 (2 males); Cass Co., 22-24 Aug. 1980 (1 male, 2 females); Jasper Co., 11 Sept. 1979 (8 males, 1 female); Marshall Co., 8 Aug. 1980 (4 males); Pulaski Co., 11 Sept. 1979 (1 male, 2 females), 23 Aug. 1980 (1 female), 21 Aug. 1981 (2 males, 2 females); Starke Co., 21-24 Aug. 1981 (19 males, 19 females); White Co., 29 Aug. 1980 (6 males); all collected by and in the collection of Wes Bicha.

*Panorpa submaculosa* Carpenter. INDIANA, Brown Co., 2 June 1976 (2 males), 19 May 1979 (4 males, 3 females), 21 May 1981 (14 males, 9 females); Lagrange Co., 13 June 1979 (2 males); all collected by and in the collection of Wes Bicha.

*Bittacus occidentis* Walker. SOUTH DAKOTA, Jackson Co., Big Buffalo Creek N of Cedar Pass, 8 July 1964, D. G. Ferguson - 1 male (USNM). This widespread species has been found from western New York southward to South Carolina and Alabama, westward to Iowa and Nebraska and southwestward to Texas and Arizona.

*Bittacus panamensis* Byers. VENEZUELA, Guarico Hato, Masaguaral, 24 km S of Calabozo, 20-28 May 1985, Menke and Carpenter - 1 male (USNM); COSTA RICA, 14 km S of Cañas, 24-31 Aug. 1990, F. D. Parker - 1 male (USU); previously recorded from Panama and Trinidad.

*Bittacus pilicornis* Westwood. ALABAMA, Winston Co., 8.9 km NE of Double Springs, 19 May 1993, G. W. Byers - 6 males, 9 females; MISSISSIPPI, Lee Co., Tombigbee State Park, SE of Tupelo, 18 May 1993, G. W. Byers - 2 males, 6 females; Winston Co., 16 km NE of Louisville, Tombigbee National Forest, 18 May 1993, G. W. Byers - 1 male, 7 females; LOUISIANA, Winn Parish, Gum Springs Recreation Area, Kisatchie National Forest, 17 May 1993, G. W. Byers - 2 males, 4 females; TEXAS, Cherokee Co., U.S. Hwy. 69, 7.4 km N of Jacksonville, 14 May 1993, G. W. Byers - 5 males, 3 females; Houston Co., 45 km W of Lulkin, 14 May 1993, G. W. Byers - 3 males, 3 females; Jasper Co., Boykin Springs, Angelina National Forest, 24 km NW of Jasper, 16 May 1993, G. W. Byers - 1 male, 2 females; San Augustine Co., Piney Woods Conservation Center, about 17 km SE of Broadus, at light, 15 May 1993, G. W. Byers - 1 male, 1 female; all in SEM. Wes Bicha adds the following locality-date information based on specimens in his collection: ALABAMA, Coosa Co., 28 May 1989 (1 male, 1 female); DeKalb Co., 27 May 1989 (2 males, 2 females); Lawrence Co., 31 May 1982 (1 male, 2 females); Marion Co., 30 May 1982 (1 female); Pike Co., 23 May 1986 (1 female); Winston Co., 30 May 1982 (1 female); MISSISSIPPI, Hinds Co., 25 April 1981 (1 male); Lauderdale Co., 24 May 1986 (2 females); Lee Co., 30 May 1982 (3 females). A widespread species, *B. pilicornis* was recorded earlier from Massachusetts westward to Wisconsin, Kansas and Arkansas and southward to northern Florida; somehow it was not recorded previously from farther southwest, for it was fairly common at every likely habitat sampled, from eastern Texas to Alabama.

*Bittacus punctiger* Westwood. ALABAMA, Hale Co., Payne Lake, Talladega National Forest, about 38.5 km SE of Tuscaloosa, 25 May 1978, G. W. Byers - 3 males, 3 females (SEM). Since the only earlier record from Mississippi was without complete data, Wes Bicha provides the following: Lauderdale Co., 24 May 1986 (1 female). This species was already known from Maryland westward to Indiana and Texas, southward to Florida, so these records are not surprising.

*Bittacus strigosus* Hagen. ALABAMA, Limestone Co., 30 May 1982, Wes Bicha (4 males; WB); Marion Co., 30 May 1982, Wes Bicha (1 male, 1 female; WB). WYOMING, Converse Co., 16 km S of Douglas, 27 Aug. 1962, W. J. Hanson - 1 male, 1 female (SEM). The species had previously been recorded from New England and New York westward to Manitoba and Montana and southward to Arkansas and South Carolina.

*Hylobittacus apicalis* (Hagen). ALABAMA, Lawrence Co., 31 May 1982, Wes Bicha (1 female; WB); Limestone Co., 30 May 1982, Wes Bicha (2 females; WB).



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